Engineering

Engineering News-Record

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May 2, 1918

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ntinuous Trusses of Silicon Steel in Allegheny River Bridge

New Machine Tests Resistance of Concrete Mixtures to Heavy Road Traffic

By H. S. MATTIMORE

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AND CONTRACTING

E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

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Fuel Outlook for Next Winter

IN ORDER to prevent a repetition of the fuel situation of last winter, we must move to and store at points of consumption before next December the large quantities of coal needed for the winter peak. Supplies should now be going forward from the mines in tremendous volume. As a matter of fact, the coal is not moving. Weather conditions are good, the miners are idle. The chief cause is lack of cars, despite the inauguration of the zone system of distribution, adopted by the fuel administration for the very purpose of releasing cars. The cars have been released, but they are moving material other than coal. In pre-war times 35 per cent. of the total freight traffic was coal; now it is 28 per cent. Obviously, the situation is difficult. Munitions must be moved to seaboard; the factories must have great quantities of raw materials. However, unless we are to shut down plants next winter by the wholesale, someone must soon order the railroads to ship coal. With such an order must go directions as to what should not be shipped. Instead of less Government interference, we must expect more. It is the only way to bring order out of the transportation chaos.

Growing Sentiment for Association Affiliation

GROWING sentiment in favor of affiliation with the American Water-Works Association was shown last week at the annual convention of the Southwestern Water-Works Association. The interesting proceedings of the latter reported on p. 883 indicate that it would form a live and useful section of the American association. Next year full knowledge of what the national organization is doing and can do for the individual superintendents might well be presented at the convention of the Southwestern association by accredited national delegates. This would no doubt go far toward strengthening the Southwestern, enlarging its usefulness in a rapidly developing field which the American association can serve only by a strong sectional representation with local conventions discussing the peculiar problems of the great Southwest.

Resistance of Concrete to Modern Highway Traffic

METHODS of testing which do not yield results measurable in terms of physical constants have, nevertheless, a very definite value when they give short-time and palpable evidence of the effect of destructive forces which, in service, would require a considerable period for their development. Of this nature is the test for concrete and concrete materials described on p. 861. The action of traffic on concrete roads has been observed to be similar to the wear produced by the machine designed in the laboratory of the New York State Highway Department, and while there is probably no warrant for the evaluation of different mixes and aggregates by weighing the specimens before and after testing, the indications furnished by the worn surface of the test piece afford an excellent basis of judgment for anyone who is sufficiently familiar with the manner in which concrete wears when subjected to the impact of highway traffic.

Water-Works Program Should Attract Many to St. Louis

FOREHANDEDNESS in getting out a well-balanced program, combined with a central and attractive meeting place and certainty of a hearty welcome, promises well for the convention of the American Water-Works Association at St. Louis, Mo., May 13 to 18. The special sleepers from New York, Philadelphia and points intermediate between there and St. Louis (see p. 881) deserve heavy patronage. The fact that these are war times should be a reason for attending instead of an excuse for staying away from the convention, which is bound to give instruction and inspiration in water-works operation. A resolution dealing with war-time matters has been framed by the executive committee for discussion at the convention. Important amendments to the constitution, drafted by a special committee, will come up for adoption. These are only some of the many reasons for expecting a large attendance and a most successful meeting of the whole water-works fraternity at St. Louis week after next.

Intensive Education Under War Spur

EVEN education is not to be without rewards from the present struggle. Witness the experiment in intensive training of technicians and mechanics, under the War Department's Committee on Education and Special Training, recounted in the news section of this issue. What does it presage for the boys and girls who, hitherto, have had to leave school at 14, and have found it impossible to receive special training because those courses took more time than they could give? How easy it will be, for educators with war-revised points of view, to slip in highly specialized intensive work of a practical character in the final year of the grade schools, to revise evening school instruction to accomplish present results

in one-half or one-fourth the time, or with an expenditure of equal time to carry the student twice as far as he can now go. The experiment is starting well. Impelled by a serious war need, the control of the studies as to practicality will be very close. Unquestionably, new methods will be discovered, especially since, at the beginning at least, much latitude will be allowed the teachers. Central control will then quickly put into general use an obviously improved method, no matter where developed. A year hence, we can safely predict, we shall be able to record very considerable progress in special training of this kind.

Let the Federal Government Do It

SOME reasons that would hold good in normal times underlie the refusal of New York State to exploit its own expensive canal system, but the main cause of the series of delays appears to be an unfortunate willingness to let the Federal Government do all the work. In this case, the argument for development by the nation has validity because the benefits to be derived are national and temporary. The temper in which it is accepted, however, is suggestive of the old pork barrel days and is serious because of its example to other state and local governments. The local disposition to take whatever comes along in the way of Federal funds is particularly evident already in the carrying out of the new housing program. Every city in the country with the slightest claim on Government aid is hounding Washington for some of the hundred millions which will go into houses for war workers. Regardless of the fact that every war industry means more business for the town where it is located and forgetful of a proper self-respect in caring for local development, the promise of free homes or easy money has become a sweet smell in the nostrils of chambers of commerce and boards of trade. To all such, a recent hint from Mr. Hurley may be a warning. In reply to one such trade body, he said that in letting future contracts the Shipping Board would remember to pass by those cities whose resources were too small to provide locally financed relief where housing accommodations were overtaxed.

Railway Efficiency Is Disregarded

EFFICIENCY in transportation is too important to the country's welfare to be the plaything of politics, pique or local interest. This truth appears to have been disregarded by the New York State Legislature in killing last month the project for the cut-off planned to eliminate the bad operating conditions of the New York Central R.R. in the vicinity of Albany. Our railways have tremendously important work to do, and it is to be presumed, after the winter's experience, that the legislators are able to appreciate it. There is definite knowledge that increased train capacity and shortened time of freight transit on the New York Central would result from construction of the bypass, crossing the Hudson at Castleton and relieving the Albany trackage, now the worst traffic point on the system. Whence came the legislative opposition, then? Ostensibly it was directed against the obstruction to navigation presented by a two-span bridge; the Legislature insists on a single span —which would be more than 1100 ft. long between piers and by its great cost would make the entire project impossible. In this the state authorities, who have no jurisdiction over river engineering or navigation, boldly take issue with the War Department, which has approved the two-span bridge as not injurious to navigation. Since the Legislature has no authority over bridge construction, it gained its end by making the connecting railway's charter dependent on the one-span demand. The very nature of this extralegal proceeding indicates the unsoundness of the motives back of it. The Legislature has put itself in the position of stopping a badly needed traffic improvement for reasons that will not bear the light. It has made a serious mistake. Reconsideration and repeal of the act are called for.

Railway Improvement Should Proceed on a Large Scale in 1918

MAINTENANCE and betterments (the latter taken as distinct from construction of new lines and extensions) bulk large in the expenditures of our railroads each year. It has been urged by some unfamiliar with conditions that such work should now be reduced and all energy devoted to the handling of traffic. The fallacy of such a policy is obvious. Much of this work is necessary for safe and efficient operation. Traffic causes wear and tear, which must be made good. Normal and abnormal increases in traffic, furthermore, demand expansion in facilities.

Maintenance work reduced below a certain limit results in deterioration which will necessitate disproportionately large expenditures in the future to bring the property back to normal. In the same way, arbitrary reduction of improvement work may mean delay and difficulty in handling the traffic at a time when promptness and expedition are vitally necessary. The problem is one of economics in the first instance; safety becomes involved if the deterioration is allowed to go too far or facilities are greatly overtaxed.

Both the construction of new and the improvement of existing lines have been limited severely during recent years through unfavorable legislation and difficulties of financing. Deferred maintenance and expansion, therefore, have resulted in some cases in property reaching a condition where safety is jeopardized, as well as efficiency and economy of operation. But the railways find themselves restricted in two ways. On the one hand is the difficulty of providing funds. On the other, the shortage of material and labor, coupled with high prices and wages, makes it extremely difficult to plan a program with any definite expectation of carrying it through.

The first phase of the problem seems likely to be disposed of by Government provision of funds. Disposal of the other phase is still dubious. Labor is the most difficult factor in maintenance and improvement work. This is the consensus of opinion of the officials of some 30 representative railways, as shown by the analysis of the situation published on page 866 of this issue. As an extreme example it may be noted that two railways report instances where track sections have to be cared

for by the foremen alone, because laborers are not to be had.

As to materials, Government and military necessities must be provided for in the first place. Therefore, shortage of supply and delay in delivery must be reckoned with as inevitable, and special provision must be made to make the best of conditions.

The need for an extensive campaign of expansion of railroad facilities was pointed out in these columns March 14. Of equal importance is the need for putting and keeping existing facilities in shape to handle economically the exceptionally heavy traffic which is now imposed upon them. The railroads have an immense work before them in relation to the war, and every effort should be put forth to make up for the retarded development of the last five years.

Floods of Protest Over New York's Health Board Situation Reach Mayor Hylan

FROM all parts of the country floods of protest against the proposed disorganization of the Health Department of New York City are pouring in upon Mayor Hylan. Heads of city and state health departments, the president of the American Public Health Association, the president of the American Medical Association, and the Surgeon General of the United States Public Health Service, have united with one voice in urging that in this time of world crisis, when the health of our men, women and children should be conserved as never before, a deadly blow should not be struck at the health work of the largest city of North America. The argument is all the stronger because the New York Health Department is the worthy model on which much of the city health administration of the country is formed.

The weakness and shiftiness of the reorganization proposed by Mayor Hylan is shown by his successive changes of front. His first alleged reason for abolishing seven of the nine central bureaus and placing their work under the sanitary superintendents of the various boroughs was economy; the next illegality; then there was much talk of graft. Later, as the tide of protest rose, it was said that at least the bureau of health education must go; that its chief function was to puff itself and the Health Department.

This allegation showed not only woeful ignorance of what the bureau does but also an utter failure to appreciate one of the most important functions of up-to-date public health work. As Surgeon General Rupert Blue well said in his telegram to Mayor Hylan: "Publicity is an essential of public health work. Urge you will not curtail activities of city Health Department of New York in informing public concerning disease and disease prevention." In the course of a more lengthy protest, Dr. C. H. Mayo, president of the American Medical Association, urged that "the information contained in your weekly health report is not only good for the citizens of your community but for the public in general."

A still more pointed protest was made on Monday of this week when Dr. J. Lewis Amster, health commissioner of New York City, sent his resignation to Mayor Hylan after ineffectual pleas and protests against the mayor's harmful interference with the affairs of the department. This sacrifice is in line with a suggestion which was made on p. 746 of *Engineering News-Record* of Apr. 18.

The health of New York City is a vital element in the defense of the nation and thus of free people the world over. It must not be sacrificed to political ambitions, to an aversion to trained men and women in municipal service—contemptuously dubbed "experts"—nor to the personal whims of any individual, even should he be the mayor of New York City.

Concrete Strength Depends Chiefly On Water-Cement Ratio

THE article by Prof. D. A. Abrams on the basic principle of concrete mixes which appears on p. 873 is noteworthy for the consistency of its data and the simplicity of its indications. The studies which have been carried out in the Structural Materials Laboratory of Lewis Institute are entirely without precedent, bringing out clearly the fact that former studies of this kind have failed to reveal the elemental principles of concrete proportioning. Past failures can be traced to the circumstance that but little systematic effort was made to analyze the factors which affect the strength and other properties of this material.

The investigation described in this issue shows that the strength of concrete for given materials, made up and tested in a similar manner, depends upon nothing except the relation between the amounts of water and cement in the mix. This is true so long as a plastic mix is secured, and indicates that the aggregate plays no part in the strength of the concrete except in so far as its properties affect the quantity of water required.

These investigations also lead to many important conclusions regarding the testing of cement. For instance, it is Professor Abrams' belief that the whole scheme of cement testing should be radically modified. The data in the article suggest that if strength tests of cement were made on neat specimens of such a consistency that the water content were the same as that used in ordinary concrete mixes, a strength would be obtained which would be an exact indication of the strength of the concrete itself—clearly intimating that the testing of cement in connection with sand or aggregates tends only to complicate the problem while not serving any useful purpose. This supposition has been remarkably borne out in the experiments which are being carried on. Professor Abrams has found that neat cement mixed with about twice the amount of water indicated by the test for normal consistency exhibits, in compression, about the same strength as is shown by a 1:2:4 concrete specimen in which the relative quantity of water is about the same.

Since purely physical facts are found inevitably by systematic study, it is unfortunate that there are not a greater number of laboratories devoting their attention to the many problems, so far indeterminate, with which the engineer has to deal. The example of the Portland Cement Association in bearing so great a part of the cost of Professor Abrams' work is one that should be followed more frequently.

Continuous Trusses of Silicon Steel Feature New Allegheny River Bridge

Sharp Departure from Precedent in Bridge Design—Minimum Weight Desired for Economy and To Facilitate Cantilever Erection—Reactions Adjusted by Jacking—High-Strength Eyebars of New Kind

WHERE the Bessemer & Lake Erie R.R. crosses the Allegheny River a new double-track deck bridge proportioned for modern loading has just been built to replace a light single-track structure. The renewal presented a problem of unusual complication, in solving which the engineers were led to adopt a strikingly original solution.

The old bridge had simple spans. In the new bridge the six main spans, ranging from 272 to 520 ft., are continuous, arranged in two groups of three each. Through this sharp departure from prevailing practice the new bridge shares with its Ohio River contemporary at Sciotoville the distinction of reintroducing continuous construction into American practice in large-scale bridge work.

A special feature is a counterweight at the end of the southerly span, to counteract any uplift that might be caused by live-load on the adjoining span, 520 ft. long. The shore span was extended into the rock bluff, about 100 ft. back of the old abutment, to obtain sufficient anchor-span length, but a 350-ton concrete counterweight block was required in addition. The block is molded around the end sway-frame, and occupies the full width between trusses and the height from jacking girder to floorbeam.

The new bridge is made noteworthy also by its material. Silicon steel was used for the stiff members, while the eyebars—used for all tension members not subject to stress reversal—are of a new kind claimed to be equal to nickel-steel eyebars. The builders give no information as to the method of making these eyebars. Results of strength tests are quoted farther on.

Both the continuous construction and the choice of material were in large part due to the necessity for erecting the bridge by the cantilever method, which under the conditions governing the work required a design of minimum weight for the desired load capacity. Other difficulties of the case had contributory influence, however, and the fact that the adopted solution proved the cheapest was the controlling consideration.

Since the erection method was fixed, the relative costs of different types of bridge were practically expressed by their relative weights—after adding the extra section required for erection stresses—and therefore the weight economy of the continuous design meant corresponding gain.

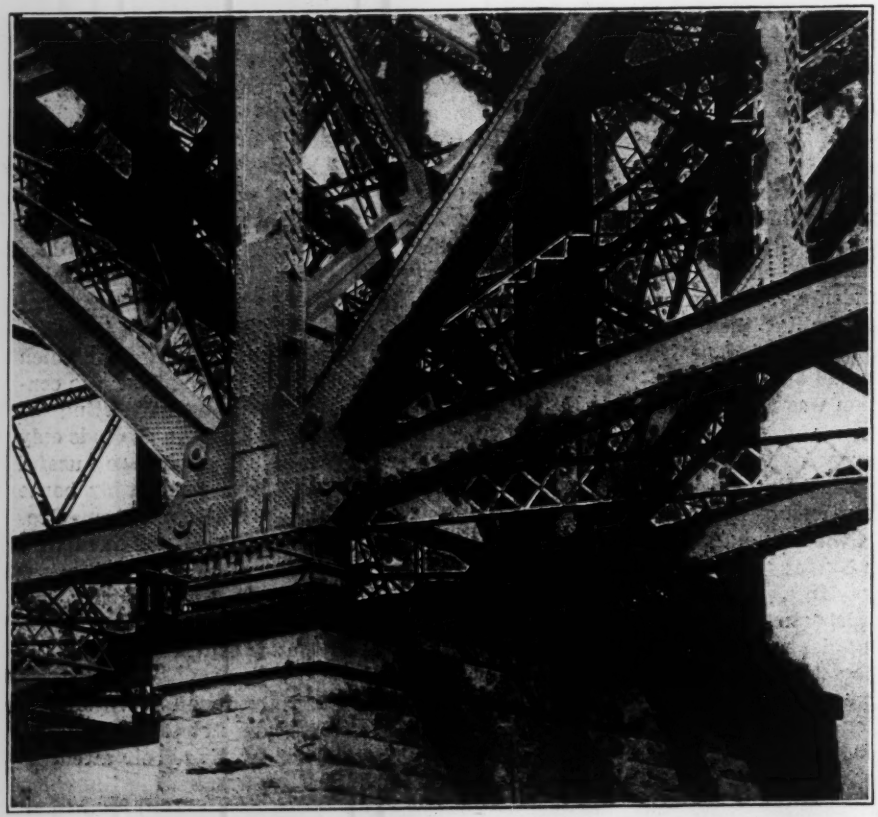


FIG. 1. NEW BRIDGE WILL BE ROLLED TO CENTRAL POSITION ON PIERS AFTER OLD BRIDGE IS DISMANTLED

Far half of pier is to be cut down after removal of old structure. Pier girders prevent concentration of load at edge of masonry. At the four main bearings the truss panel-point acts as upper shoe. Locking plates of rockers were removed when last span was being closed.

The old bridge was built in 1896, for E40 loading, which then was heavier than existing railway loading. The Bessemer & Lake Erie transports large quantities of iron ore, in which class of traffic the greatest increase in train weights has occurred. Its present maximum train weights are in excess of E50. For some years the bridge had been overloaded, to the extent even that double-headed trains had to shift one engine to the rear before crossing. But the inadequate traffic capacity of the single track was equally hampering. In 1914, therefore, replacement was taken in hand. It was studied jointly by H. T. Porter, chief engineer of the railway, and C. G. E. Larsson, assistant chief engineer of the American Bridge Co.

Some of the governing conditions of the problem were

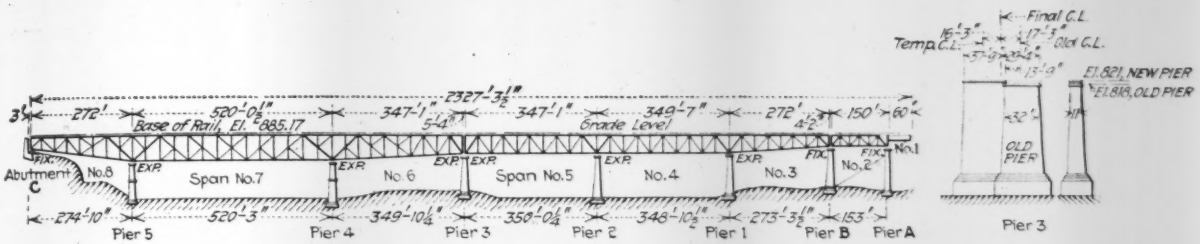


FIG. 2. DIAGRAM OF NEW CONTINUOUS-SPAN BRIDGE OVER ALLEGHENY RIVER BUILT FOR ORE-TRAIN TRAFFIC

the absolute necessity of maintaining traffic at all times; the importance of avoiding falsework in the river (as the Allegheny is considered dangerous to temporary timber work that must be maintained for a long period); the desirability of improving the profile of the road by raising the track 10 ft. at the north end of the bridge so as to make the grade level and eliminate a highway grade crossing; the existence at the north end of a 1200-ft. approach viaduct 130 ft. high; and the comparative weakness of the old piers in the direction of the track. It was thought at first that the bridge would have to be built on new alignment, but finally a practicable method of building on the existing alignment, with use of the old piers, was developed.

An essential feature of the solution was replacement of the north approach viaduct by a fill. This remarkable operation, in which two steel viaducts—the old one and a dumping viaduct built alongside—are buried, was described in *Engineering News* of Feb. 22, 1917, p. 322. The fill is not yet completed, delay having resulted from railway conditions during the last season and also through the occurrence of excessive lateral pressure of the fill on the viaduct.

For the river bridge, the replacement involved the following procedure: Widening the single-track piers on the old footings, which had been built of double-track width originally, and erecting the new bridge alongside the old one, since the piers as widened were long enough (with the help of pier girders) to accommodate both structures side by side; then transferring traffic to the new bridge and dismantling the old; and, finally, rolling the new bridge over into central position on the piers. The erection was begun at the two ends, by building the shore spans on falsework. All the other spans were cantilevered, and the work proceeded by continuous cantilever operation to closure at the middle of the 520-ft. span.

To avoid overstress in the pier masonry under the action of braking forces, the bearings on all the river piers were provided with expansion rollers, the two ends

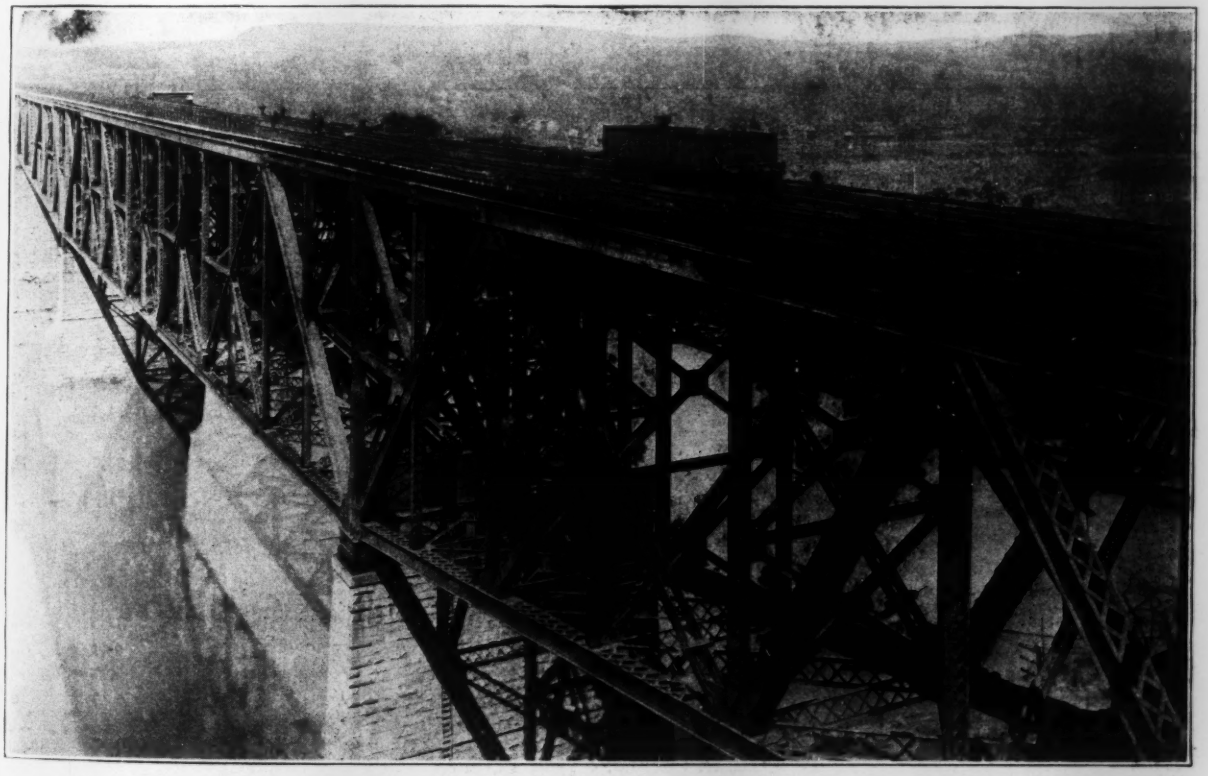


FIG. 3. HIGH-STRENGTH STEEL AND CONTINUOUS CONSTRUCTION RESULT IN A STRUCTURE OF LIGHT APPEARANCE

Looking north from south bank. The span beyond the first pier is 520 ft. long. Designed for E75 loading, this double-track bridge is among the heaviest to be found in our railway system.

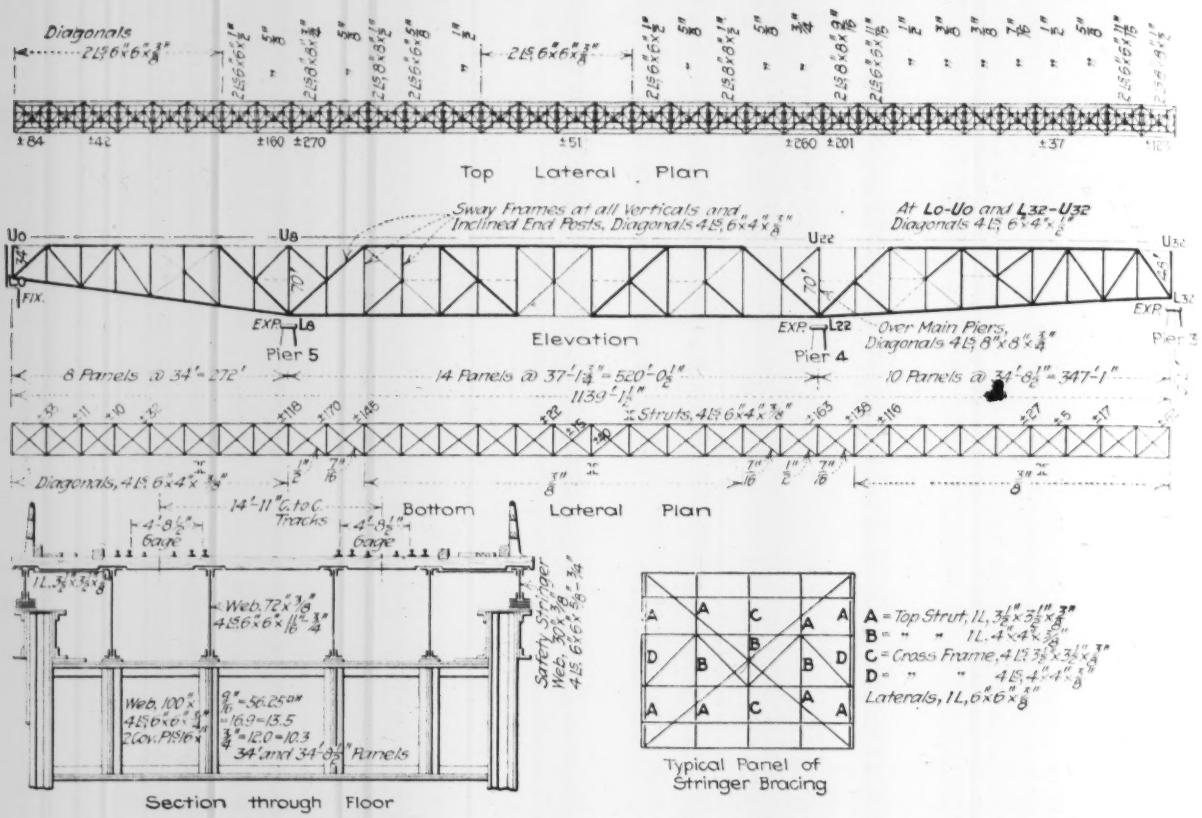

Diagonals
Top Lateral Plan
Sway Frames at all Verticals and Inclined End Posts, Diagonals 4L's 6"x4"x 3/8"
At Lo-Uo and L32-U32 Diagonals 4L's 6"x4"x 1/2"
Uo
U8
U22
U32
Lo
L8
L22
L32
FIX.
EXP.
Pier 5
Pier 4
Pier 3
Elevation
Over Main Piers, Diagonals 4L's 8"x8"x 1 1/4"
8 Panels @ 34'-2 7/8" = 272'
14 Panels @ 37'-1 3/4" = 520'-0 1/2"
10 Panels @ 34'-8 1/2" = 347'-1"
1139'-1 1/2"
Struts, 4L's 6"x4"x 7/16"
Diagonals, 4L's 6"x4"x 3/8"
14'-11" C. to C. Tracks
4'-8 1/2" Gage
Bottom Lateral Plan
Web, 72"x 3/8" 4L's 6"x6"x 11/16"
Web, 100"x 4L's 6"x6"x 9/16"
2 Cov. PL's 16"x
34' and 34'-8 1/2" Panels
Safety Stringer Web, 30"x 5/16" 4L's 6"x6"x 5/16"
Section through Floor
A = Top Strut, 1L, 3 1/2"x 3 1/2"x 7/16"
B = " " 1L, 4"x 4"x 5/16"
C = Cross Frame, 4L's 3 1/2"x 3 1/2"x 7/16"
D = " " 4L's 4"x 4"x 5/16"
Laterals, 1L, 6"x 6"x 7/16"
Typical Panel of Stringer Bracing

FIG. 4. CONDENSED STRESS-SHEET OF SOUTH-SPAN GROUP—ALL TENSION MEMBERS ARE EYEBARS

Number	Dead	Maximum Stresses: Live	Impact	Total	Erection	Material		Sectional Area: Gross	Net
Uo-U1						2-15 in. channels, 33 lb.	Carbon steel	19.8	
U1-U3	—189	—1,175	—417	—2,099	—1,220	Cov. 36x½	2 Webs 36x½	114.1	
		674	151	954	150	2 Ls 6x4x½	2 Ls 6x6x½		
U-3-U6	52	1,133	402	2,191	—1,350	Cov. 36x½	2 Webs 36x1 1/16	129.8	109.7
		1,115	250	2,125	650	2 Ls 6x4x½	2 Ls 6x6x½		
U6-U8	1,170	1,946	310	3,426	2,220	6 Bars 14x1½	(U8-U10 same)	126.0	
U10-U12	—712	—1,489	—333	—2,534	—2,090	Cov. 40x½	2 Ls 6x6x½	136.1	
					380	2 Ls 6x6x½	2 Webs 40x1		
U14-U16	1,181	2,212	495	3,888	—2,600	Cov. 40x½	2 Webs 40x 5/16	208.8	
						4 Ls 6x6x½	4 Webs 40x½		
U22-U24	1,439	2,220	327	3,986	2,580	6 Bars 14x1 1/16		152.3	
U26-U28	—670	1,875	—566	—3,263	—2,203	Cov. 36x½ 2 Ls 6x6x½	2 Webs 36x 5/16		
		796	179	457	1,830	2 Ls 6x4x½	4 Webs 36x½	170.3	
L8-L10	—72	—426	—152	—881	—1,110	4 Ls 6x6x½	2 Webs 36x½	82.4	
		370	165	694	1,260				
					—270	4 Ls 6x6x½	2 Webs 36x½	150.8	125.8
L12-L14	811	1,637	366	2,814	2,190		4 Webs 36x 5/16		
L14-L16	1,062	2,064	462	3,588	2,530	6 Bars 14x1½		136.5	
L22-L24	—369	—1,383	—310	—2,398	1,360	4 Ls 6x6x½	2 Webs 36x½	128.3	
		800	241	1,008	—1,070		2 Webs 36x1 1/16		
L28-L30	606	1,651	499	2,834	1,860	4 Ls 6x6x½	6 Webs 36x 5/16	155.3	129.5
		623	—140	—235	—2,650				
Lo-U1	—232	—1,088	—387	—1,917	—1,152	Cov. 36x½	2 Webs 36x½	114.1	
		533	119	630		2 Ls 6x4x½	2 Ls 6x6x½		
U1-L2	42	784	311	1,409	697	4 Ls 6x6x½	2 Webs 36x½	82.4	68.4
		—480	—107	—817	—223				
L4-M5	528	812	390	1,730	—170	4 Bars 12x1 1/16	(2 Bars laced)	75.0	71.7
					1,000				
M7-L8	—1,007	—1,505	—535	—3,047	—1,840	Cov. 36x½ 2 Ls 6x6x½	2 Webs 36x 5/16		
U10-M11	1,077	1,872	476	3,425	2,030	2 Ls 6x4x½	4 Webs 36x½	170.3	
U12-M13	517	1,208	358	2,083	1,121	4 Bars 16x2 1/16		132.0	
						4 Ls 6x6x½	2 Webs 36x½	119.3	99.1
M25-L26	912	1,285	459	2,656	1,570	4 Bars 14x1 1/16	2 Webs 36x 5/16 (2 Bars laced)	101.5	97.9
					—120				
						Cov. 36x½ 2 Ls 6x6x½	2 Webs 36x½	143.3	
U31-L32	—588	—1,410	—426	—2,424	—2,160	2 Ls 6x4x½	2 Webs 36x 5/16		
U4-L4	—104	—369	—254	—727	—288	4 Ls 4x4x 1/16	2 Webs 22x 1/16	50.3	
U8-L8	—338	—658	—338	—1,334	—1,430 (Wind)	4 Ls 6x6x½	2 Webs 42x1 (U22-L22 same)	117.8	
U12-L12	—514	—1,059	—288	—1,861	—1,043	4 Ls 6x6x½	2 Webs 36x 1/16 (U18-L18 same)	101.3	
U26-L26	—568	—910	—325	—1,803	—1,060	4 Ls 6x6x½	2 Webs 36x½	96.8	
U28-L28	—197	—533	—315	—1,045	—463	4 Ls 6x6x½	2 Webs 28x 1/16	66.9	
U8-M9 M21-U22	154	285	191	630	296	4 Ls 6x4x½	1 Web 22x½	36.0	28.4
L10-M11 etc.	—130	—285	—191	—606	—272	4 Ls 4x4x 5/16	2 Webs 22x 5/16 (M23-L24 same	41.4	
L24-M25	Temp. Erection				871	4 Pls. 18x½	Carbon steel	54.0	48.0
M25-U26	127	284	194	605	962	4 Ls 6x6x½	1 Web 22x½	47.5	39.3
U24-L24	150	187	128	465	—497	4 Ls 4x4x½	2 Webs 22x½ Carbon steel	37.0	30.2
					243				
ALL OTHER SUBSTRUTS	HANGERS and U1-L1, U3-L3, M5-L5, M7-L7, U29-L29, U31-L31					4 Ls 6x4x½ 1 Web 22x½ Carbon Steel		22.6	
						2-15 in. channels at 33 lb.	Carbon Steel	19.8	

Column marked total includes 50 per cent. of smaller stress where there is reversal.

of the bridge being fixed, so that the end masonry served as anchorage against longitudinal motion. At the south end a new abutment was built back in the rock bluff, while at the north approach a new pier had to be erected and this could readily be proportioned to resist the traction forces.

Selection of the Continuous-Span Design

Essentially the adoption of continuous spans is the outcome of the designer's aim at producing the most economical structure. In the range of span length here in question, the differences in metal weight between simple, cantilever and continuous spans are in most cases equalized by differences in erection costs, when comparisons are made on the basis of normal prices of material and labor. But here the erection labor costs could not differ greatly, as the cantilever method was to be used in any event.

Simple spans would have required a considerable amount of extra material to take care of erection stresses. With cantilever or continuous trusses most of this extra material would be saved, adding to the inherent weight economy of these types. But a cantilever bridge, besides being undesirable for the short spans and heavy live-load, was not adapted to the requirement of erecting from one end of each span.

The choice as to how many spans should be connected up in a single continuous structure (from three to six; the short north approach span was never considered for inclusion in the continuous span system) was determined by the question of adjusting the reactions to their proper values. Grouping three spans in a continuous structure, only the two end reactions of the group had to be weighed off by jacks and gages to the predetermined amounts. With more spans grouped, for instance all six, as many as five pier reactions would have to be adjusted, and it was thought better to avoid this extra complication.

FIG. 5. LONG CANTILEVERING FEATURED THE WORK
Three spans of 350 ft. each were consecutively cantilevered in this way.

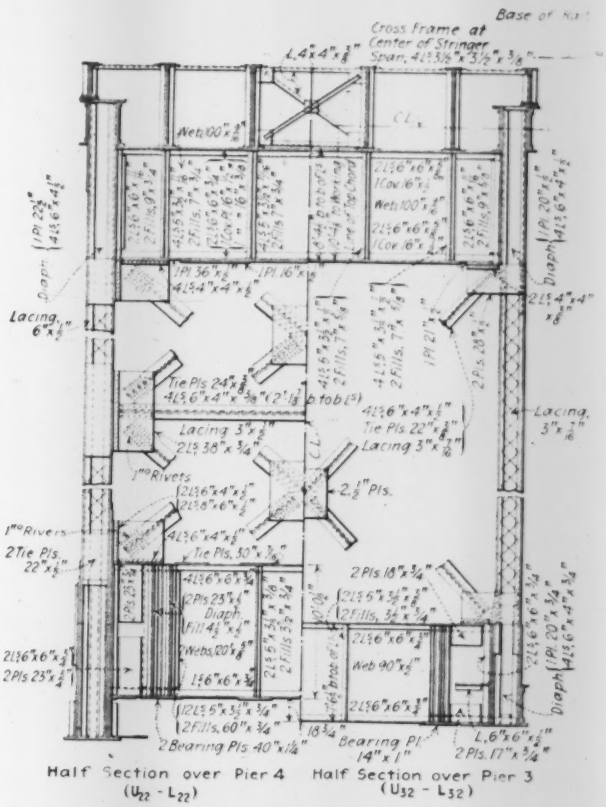


FIG. 6. JACKING GIRDERS AND MAIN SWAY-BRACING

As the erection procedure involved only 260-ft. cantilever projections in the 520-ft. span, the full-span projection of the three 350-ft. spans became the critical element of the erection. The first plan was to provide a falsework tower under each one of these spans, on which the cantilever overhang would be landed when erection had proceeded across one-half or two-thirds of the span length. However, when a design using high-strength steel was studied, it was found that the reduced weight made the full 350-ft. cantilever length practicable. A slight addition of metal in the end members of the spans for erection stresses was required, but the cost of the metal so added was less than the cost of a temporary bent, and represented a value permanently retained in the structure and adding materially to the rigidity of the completed bridge.

At the prices prevailing in 1914 the metal selected furnished also the cheapest bridge. Comparisons were based on American Railway Engineering Association unit-stresses for plain steel, 40% higher stresses for silicon steel, and 27,000 lb. per square inch for the eyebars.

Specially treated eyebars of high strength had been developed by the American Bridge Co. a short time before, and these were adopted for the Allegheny River bridge. The specifications under which they were furnished required them to show results in full-size tests equal to or exceeding the following figures: Elastic limit, 50,000 lb. per sq.in.; ultimate strength, 80,000 lb. per sq.in.; elongation, 8% in 18 ft.; reduction of area, 35%. Ten

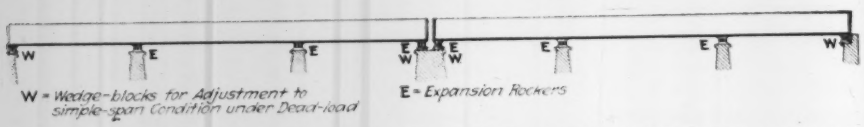


FIG. 7. EACH SPAN-GROUP ADJUSTED TO CORRECT STRESS CONDITIONS BY WEDGE BEARINGS AT END SUPPORTS

of the bars made for the bridge were tested, with the following extreme and average results:

FULL-SIZE TESTS OF SPECIAL EYEBARS

Elastic Limit Lb. per Sq. In.	Ultimate Strength Lb. per Sq. In.	Elongation In 18 Ft., per Cent.	Reduction of Area Per Cent.
53,000-63,000 av. 58,300	81,000-90,000 av. 86,300	7.8-13.2 av. 10.4	46-59 av. 52.5

DESIGN MADE FOR COOPER'S E75 LOADING

The design of the new bridge was based on Cooper's E75 loading. The engineers cited the following facts:

Ore trains now running on the Bessemer & Lake Erie have a weight exceeding 5000 lb. per lin.ft., and there is no present indication that a limit has been reached. During the past 25 years or more the increase in railway loading has averaged about E1 per year, and if this rate is maintained an E75 loading will be reached 15 or 20 years hence. Another iron-ore road, the Duluth, Missabe & Northern, already carries trains exceeding 6000 lb. per ft. Solid trains of 100-ton ore cars may soon be operated, and they would amount practically to E70 loading. Engine loadings show at least an equal rate of growth. Passenger locomotives are now operating with 73,000 lb. on an axle; if the same axle loading should be adopted for freight locomotives the result would be not far from the Cooper E75 engine. The final adoption of E75 loading expressed the conclusion that it is a reasonable future contingency as to both engine and train weight.

Since railroad practice in general, apart from that on special ore-carrying roads, has shown a greater growth of engine weight than of train weight, some study was given to a departure from the Cooper type of loading making allowance for the greater probability of engine-weight increase. A loading consisting of two E75 engines followed by a train weighing 6500 lb. per lin.ft. was compared with a straight E75 loading. It was found that there would be little difference in stresses in this type of bridge, because most of the stress maxima occur under short load segments; little could be saved, therefore, by holding train loading to 6500 lb.

In designing the continuous spans a first approximation to the required distribution of metal was obtained by using ordinary continuous-girder formulas based on constant moment of inertia. The resulting design was then analyzed, corrected and re-analyzed by deflection calculations. Instead of taking the dead-load reactions at the amount corresponding to the condition of level supports, however, they were fixed arbitrarily at an early stage of the calculations, and the final adjustment

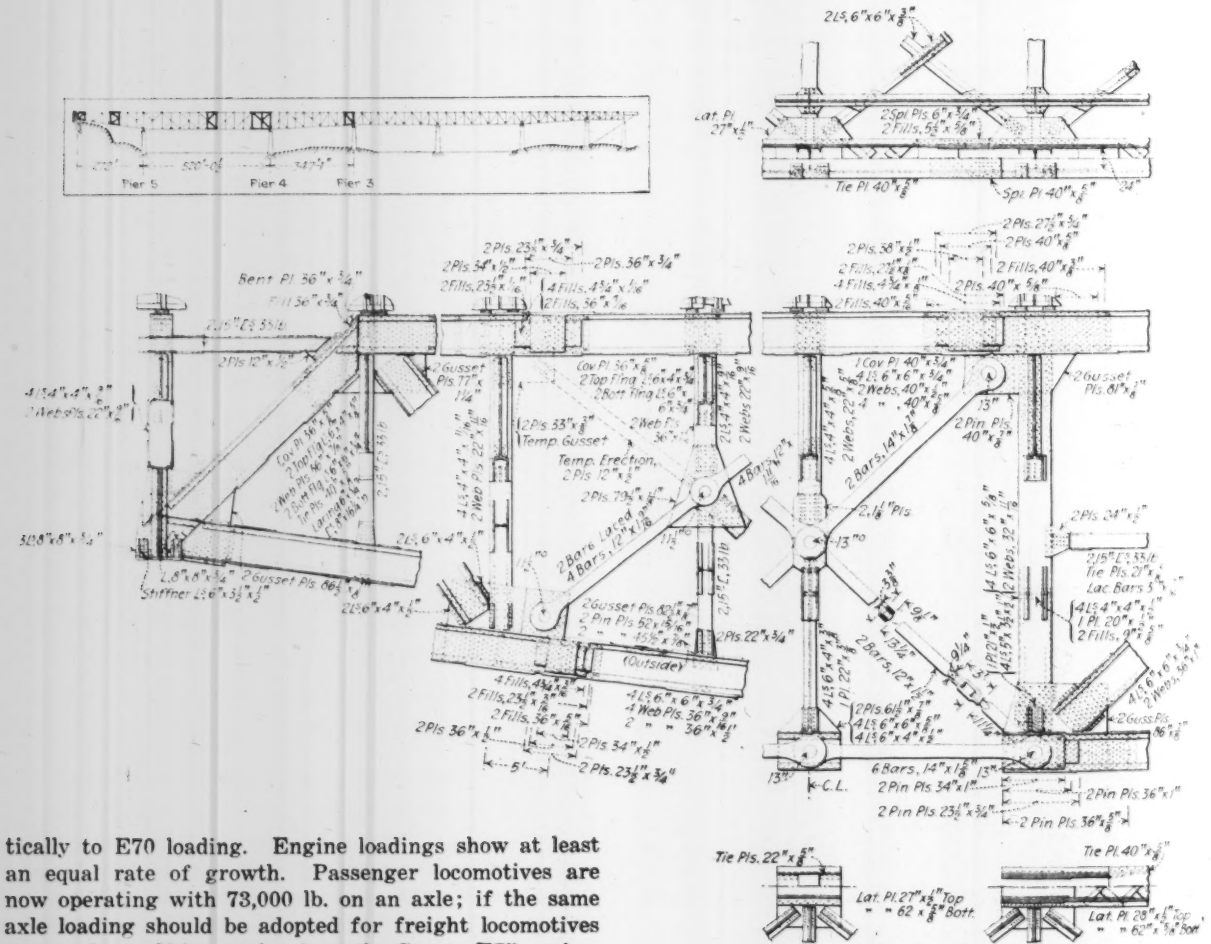

Pier 5
Pier 4
Pier 3
Bent Pl. 36"x 3/4"
Fill 36"x 3/4"
2 Pls. 10"x 1/2"
2 Gusset Pls. 77" x 1/4"
2 Pls. 33"x 3/8" Temp. Gusset
Temp. Erection 2 Pls. 10"x 1/2"
2 Pls. 79"x 1/2"
2 Pls. 22"x 3/4"
(Outside)
2 Pls. 36"x 1"
2 Pls. 34"x 1"
2 Pls. 23 1/8"x 3/4"
Cov. Pl. 40"x 3/4"
4 Ls. 6"x6"x 3/4"
2 Webs, 40"x 5/16"
2 Bars, 14"x 1 1/8"
2 Pin Pls. 40"x 2"
2 Gusset Pls. 81"x 1"
2 Pls. 34"x 1"
2 Pin Pls. 34"x 1"
2 Pin Pls. 36"x 1"
2 Pin Pls. 23 1/8"x 3/4"
2 Pin Pls. 36"x 1 1/8"
6 Bars, 14"x 1 1/8"
Tie Pl. 40"x 1"
Lat. Pl. 27"x 1"
2 Spl. Pls. 6"x 3/4"
2 Fills, 5 1/2"x 3/8"
Spl. Pl. 40"x 1"
Tie Pls. 22"x 1"
Lat. Pl. 27"x 1/2" Top
Lat. Pl. 28"x 1/2" Bott.

FIG. 9. TYPICAL DETAILS OF SOUTH SPAN-GROUP—DIFFERENCE IN LEVEL OF OLD AND

of the bridge after erection was accomplished by jacking up until the end reactions equaled those used in designing.

The dead load was assumed at 10,200 lb. per lin.ft. of bridge, consisting of 1900 lb. for the deck and 8300 lb. for the steel. For the live-load, impact was computed according to the A. R. E. A. specifications.

In continuous spans many members get their maximum stresses under broken load; i.e., two or more separated blocks of load. An unusual procedure was followed with respect to such loading. The stress due to broken load was not considered unless it increased the unit stress 25% beyond that allowed by the specifications, or unless it produced reversal of stress; in the former case, a 25% increase in unit stress was allowed in computing the section. The small probability of short lengths of train occupying just the required panels, with no load elsewhere on the structure, was at the bottom of this allowance.

In designing members subject to reversal of stress, it was assumed that the entire dead-load would be effective in counteracting live-load stress, which departs from the usual assumption intended to provide for reduced weight of deck, increase of live-load, and other effects. The member was designed on the basis of stresses found by increasing the maximum stress in each direction by 50% of the smaller. The connections in all cases were proportioned for the stress as thus increased, unless erection stresses required still more rivets.

Wind loads were assumed as follows: On the top chord, a distributed load of 30 lb. per sq.ft. of exposed surface of both trusses and the floor, and a moving load of 750 lb. per lin.ft.; on the bottom chord, a distributed load of 50 lb. per sq.ft. of exposed surface of both trusses. Wind during erection was taken at 30 lb. per sq.ft. of exposed surface. The unit stresses for combined wind and vertical load were increased 25% above

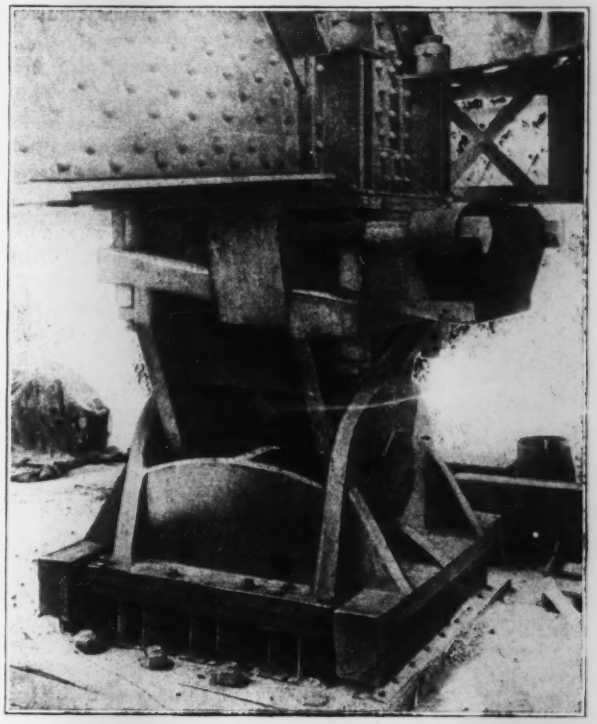
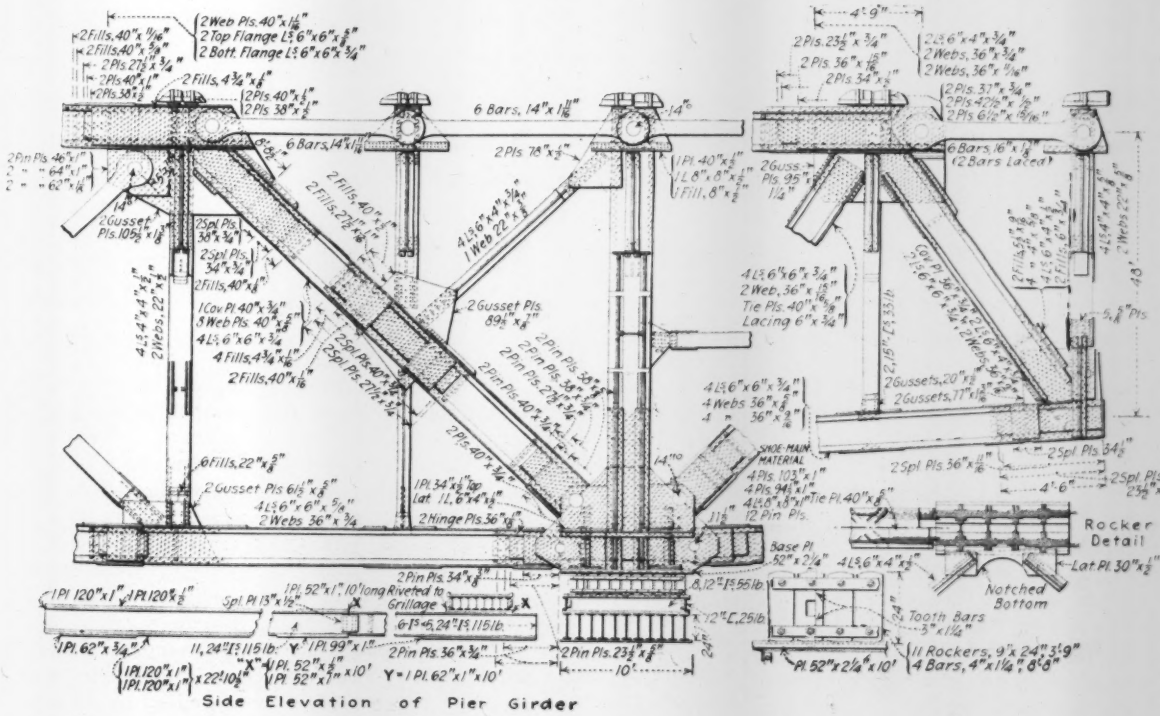


FIG. 8. FIXED-END SHOE WITH ADJUSTING WEDGES
When the three spans of a group were completely erected, hydraulic jacks were set under the jacking girders at the ends of the group; after lifting until the desired reaction is obtained, the wedges are drawn up.



COMPACT CONNECTIONS OBTAINED BY USE OF LARGE RIVETS
NEW MASONRY REQUIRED SPLICED PIER GIRDERS

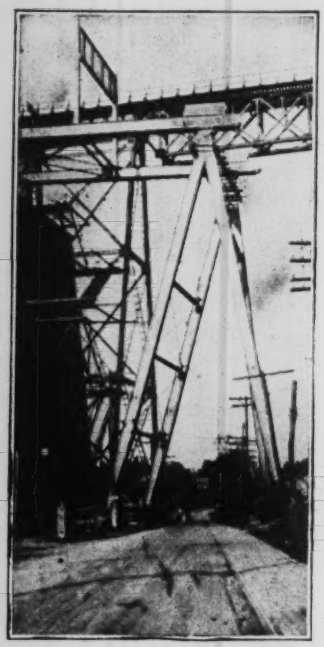


FIG. 10. SUPPORT OF NORTH SPAN DURING ERECTION

those normally allowed by the specification, and for combined wind and load during erection conditions, 50% above normal. The single-track deck used in cantilever erection was computed as weighing 500 lb.; with one pair of stringers and bracing, it formed the floor load on the cantilever. The live-load consisted of a derrick car taken as weighing 212,000 lb. When the new bridge is completed, the old bridge will be supported from it by bracket connections, while being dismantled; stresses due to this weight, with E50 loading on the far track of the new bridge, were considered erection stresses. Carbon steel was used wherever rigidity or minimum section governed: In vertical hangers supporting the bottom chord, horizontal struts (secondary members in the truss system), safety stringers, shoes, grillages, and all lateral and sway bracing. Members over the abutments also were made of carbon steel. The rivets (as already noted) and all pins were of the grades ordinarily used. The bearing pressure on pins was taken at 30,000 lb. per sq.in., while for rivet stresses those of the A. R. E. A. specification were taken.

Stresses in the lateral bracing, which is continuous just like the main trusses, were calculated by the three-moment formula, assuming uniform moment of inertia and no sheer deflection. A stress sheet of the south half of the bridge is reproduced in condensed form in Fig. 4. This half contains the 520-ft. span and the counterweighted south span. The concrete counterweight already mentioned (350 tons weight) was not placed until after completion of the bridge. During erection of the south half of the 520-ft. span the abutment end of the shore span was loaded down with a temporary counterweight of steel rails weighing 120 tons.

As in other cases where high-strength steel has been used there was some perplexity concerning the riveting. Search and experiments did not bring to light any material affording with definite certainty a higher rivet strength, so as to bring rivets and body material into the same relation as in work using ordinary steel. The only way to avoid ungainly and expensive connections was to use large rivets, and therefore 1¼-in. rivets (of ordinary rivet steel) were adopted for the main connections.

An unusual rivet-hole specification was written, because of the use of silicon steel and extra large rivets. The intent of the specification is to limit the material punched to a thickness $\frac{1}{16}$ in. greater than the punch diameter, and at the same time have ⅛-in. of metal left for reaming (¼ in. on the diameter). The clause reads as follows:

> Material ½-in. thick or less shall be punched full size. Material over ½-in. thick, but not more than ¼ in. less than the nominal diameter of the rivet, may be punched to a diameter ⅛ in. less than the nominal rivet diameter and reamed to ¼ larger than the nominal rivet diameter. Material thicker than above specified is to be drilled from the solid. No material over 1⅜ in. thick is to be used. The edges of all main gusset plates are to be planed.

Adjustment to Correct Stress Conditions

During erection, as soon as a span was landed it was jacked up to correct level—or rather to a level 8 in. above that shown by the drawings, so as to give room for inserting the track and rollers on which the new bridge is to be rolled along the piers into final position after the old structure shall have been removed. But adjustment to design elevation only approximated the desired condition of correct distribution of the reactions, as the assembly of the members is likely to make the shape of the structure depart slightly from the diagram shape. In the final adjustment, therefore, the jacking was governed by reaction rather than by amount of lift.

The reactions produced by the jacking were equal to those used in the design calculations. These were approximately but not exactly the same as the reactions corresponding to true continuity on supports exactly fitting the unstressed shape of the bridge. To allow readjustment in case of any subsequent pier settlement, provision is made for jacking and shimming. The lower members of the sway frames over the piers are heavy girders, under which jacks may be set and the bridge raised or lowered. Shimming to the changed elevation is provided for by pairs of wedges under the end shoes of the two groups, at Pier B, Pier 3 and the south abutment. The jacking and shimming, both at time of final adjustment and at future readjustment, are done at the two end supports of each group of spans, as sketched in Fig. 7. When the end reactions are brought to the proper amounts the middle reactions will also be right. However, jacking must be done at the intermediate supports in connection with the transverse rolling of the bridge, to free the blocking, lower the bridge down upon the roller track, later free the rollers and track and lower to final bearing. Jacking girders are therefore provided here as well as at the end supports (Fig. 6), but weighing the jack loads is to be done at the end bearings only. The operations of rolling the bridge to permanent position and making the final adjustment have not yet been performed.

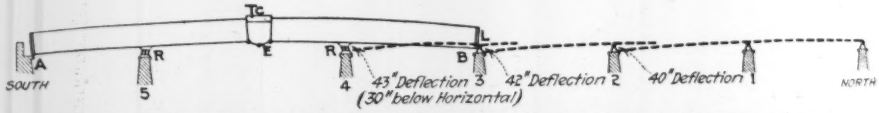


FIG. 11. DEFLECTION CONDITIONS AND FINAL CLOSURE OF CANTILEVERS

By making top-chord link L 1¾ in. short, the deflection at Pier 4 was limited to 30 in. below the horizontal, the total deflection from unstressed condition being 43 in. Link L was removed when span was landed and jacked up. To close south group, the cantilever halves were pushed forward and points A and B lowered. Eyebars E were slack when placed. After the closure section T was dropped in, jacks at A and B tipped the two arms until T came to bearing and then pulled bars E taut, rockers R coming back to vertical.

Typical details of the bridge are contained in the panel-point elevations Fig. 9 and the cross-sections Fig. 6.

The designers aimed to use the maximum economic panel-length. In the long span the length was partly controlled by the desirability of having an odd number of main panels, to get the simplest conditions for central closure. The width of the deck, 31 ft., was determined partly by consideration of convenience of providing for the lateral plates outside of the outer track stringers, and partly by the desire to make provision for future gantleting of tracks, so as to avoid switching on the approaches when four line tracks are put in. Ties long enough to extend over the entire width of deck are used, of 10 x 12-in. section.

A safety stringer was placed at the outer edge of the deck, directly over the top chord. There is only one set of stringer laterals, placed between the center stringers. In erection, the cantilever construction was carried out with only one pair of stringers (the middle pair) in place, in order to reduce the weight of the overhang; as these stringers required a lateral system in order to carry the derrick-car loads safely, the adopted arrangement avoids subsequent shifting of stringers or laterals. The cross-frames which brace the unsupported stringer flanges are carried out to the edges of the deck and here connect with a safety stringer along each edge.

The shoes at the four points of end bearing are of cast steel, in conformity with normal practice. At the intermediate bearings, however, no separate shoes are used, but the truss panel-point serves as upper shoe and grillage on the pier girders as lower shoe. The lower and upper roller plates which inclose the rockers are in direct contact with these two parts. The panel-point assemblage being pin-connected to four of the abutting members, it was considered a degree of adjustability practically equivalent to that of a pin-shoe bearing is obtained.

Expansion on the middle pier must take care of the entire 2200-ft. length of the river bridge. Using the customary allowance of 1 in. expansion per 100 ft. length of bridge, 22 in. of expansion clearance is provided, half at each of the two adjoining shoes. The rockers are unusually large, being 24 in. in diameter.

Fabrication of the bridge material involved no special features beyond those introduced by the rivet-hole drilling-and-reaming specification already noted. The truss members were built to full-load camber, each member being made of a length equal to its geometric length plus or minus the full-load compression or tension respectively, with a view to producing the true diagram outline under full load. The angles between the members at the connection points, however, were made as required for connecting up in the unstressed condition; that is, there was no attempt to eliminate secondary stresses. The trusses were in general not assembled in the shop yard for making the connections, but the gusset plates were drilled to iron templets.

Erection was handled by a 60-ton derrick car of the Mitchell type. The choice of equipment was partly controlled by the necessity of keeping the load on the overhanging spans in the cantilever erection down to a minimum in order to avoid excessive erection stresses.

The cantilever erection progressed from either end to closure at the middle of the 520-ft. span. This meant that the north span of the south group had to be erected from the north, or in other words had to be continuous with the north group for the time being. The continuity was brought about by eyebar links between the adjoining top chords, over Pier 3, and blocks between the bottom chords, which were removed as soon as the span was landed on Pier 4.

The links just mentioned were made short enough to hold the span 13 in. higher at Pier 4 than it otherwise would be (Fig. 11). The deflection of the span just before landing was 43 in., but the short links by tipping up the span held the end to 30 in. below the horizontal, giving more clearance between trusses and pier for placing the jacks. In jacking up here to release the links and blocking, however, the full 43-in. height had to be jacked, and the truss then lowered 13 in.

Large deflections occurred in the previously erected spans also. The second span from the north deflected 40 in. just before landing on Pier 2, and the next span deflected 42 in. at Pier 3.

In preparing for the cantilever work in the 520-ft. span, which was to close at midspan, the rocker bearings on Piers 4 and 5 were rendered fixed by bolting on interlocking side-plates. Just before this the two halves of the structure were pushed forward several inches, and the rear ends lowered to tip the forward ends up, so that when the meeting cantilevers came together they were too close at the bottom chord and too far apart at the top chord.

With this preparation, closing the span was an operation free from difficulty. The bottom-chord eyebars of the middle panel, which are jointed at the middle sub-panel point, were inserted and allowed to hang slack. The top-chord closing section was then dropped into place, and jacks were at once set to work raising the anchor ends of the arms. As soon as the top-chord joints came to bearing as a result of this jacking, the rocker joints on the main piers were released by taking off the fixing plates, so that the trusses might move backward at these points as the jacking continued. Further jacking drew the slack eyebars taut, and put them under tension corresponding to the desired simple-span condition.

There were some complications in the erection of the north anchor span on falsework due to local interferences. Two railway tracks pass under the span, and as traffic on them could not be interrupted a gap in the

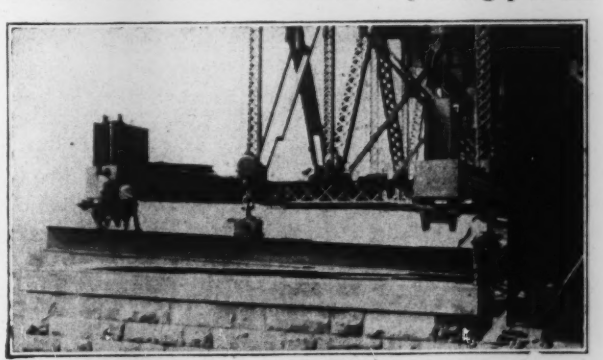


FIG. 12. DERRICK-CAR SETTING PIER GIRDERS; CANTILEVERED SPAN READY TO LAND

falsework resulted which had to be crossed by cantilever erection, requiring a steel fulcrum tower (Fig. 10) and a temporary tail counterweight.

Old Bridge Must Be Removed and New Structure Rolled to Final Position

The position in which the new bridge was erected, and its relation to the old bridge, may be seen in the cross-section sketch, Fig. 2. As the pier width is barely sufficient for both structures, pier girders (see Fig. 1) are used to prevent load concentration near the ends of the masonry and to tie the new and old masonry together. The same girders will carry the roller track required for shifting the new bridge to final position.

Before this moving the old bridge will be taken apart, after each panel-point is supported by connection to the new bridge through beam brackets and diagonal-rod hangers. Following this operation the old half of each pier will be built up to final coping elevation (made necessary by the change of grade), and the remaining sections of grillage girders placed, before preparation can be made for moving.

Rolling the new bridge to place will follow closely the precedent established by recent bridge-rolling operations. As the entire length of the movement will be on masonry, the increased resistance and frequent delay encountered when part of the support is on timber falsework is expected to be absent. The two groups of three spans will be moved successively. The shift is almost exactly equal to the track spacing on the new bridge, and it will therefore be possible to resume operation, if desired, when only one group has been moved. On the other hand the moving of the north group will be complicated by the necessity of skewing the end spans of the filling viaduct at the north approach (the filling track, at the grade of the revised profile, being then used temporarily as running track) to make connection between this viaduct on the line of the erection position and the river bridge in the final position, until the approach fill can be built up to grade.

The steel weight of the new bridge is about 10,150 tons, or 8700 lb. per lin.ft.

Both fabrication and erection were carried out by the American Bridge Co. Erection began in April, 1917, and the long span was closed February, 1918. The new bridge has carried regular traffic since Mar. 1 in its temporary position.

Designs of Workmen's Dwellings Exhibited

Industrial dwellings of the "model city" at Morgan Park, Minn., are a feature of an architectural exhibit at the Art Institute, Chicago, one room being devoted to a display of plans, photographs and paintings of the town and its buildings. This town was established a few years ago by the Minnesota Steel Co. to provide accommodation for employees at its large steel plant near Duluth. The buildings are of concrete block construction and range from single residences to long structures forming three or four residences. Wide streets with a curved layout and ample provision for gardens, playgrounds and other open spaces are characteristics of the general plan. The designs were made by Dean & Dean, of Chicago, architects for the Morgan Park Company.

Wood Tieplates Found to Be Poor Substitute for Steel

ECONOMY in track construction was the goal of extensive experiments begun some years ago in the use of wood instead of steel for tieplates to protect ties from being cut and abraded by the rails. These plates were used mainly in connection with treated ties, but were also used to some extent on untreated ties. One special advantage suggested was their application on branch lines, thus protecting the ties at much less expense than the use of steel would involve. This feature of track work was dealt with in *Engineering News* of June 21, 1906, page 694. Recent inquiry indicates that on the whole the plates have not been satisfactory, and have not given the expected service.

About 65,000 creosoted wood tieplates were applied in 1906 by the Cleveland, Cincinnati, Chicago & St. Louis (Big Four) Ry., and in 1917 only about 20% of these remained in service. They were mainly of beech and elm, 5 x 8 in. and ⅜ in. thick, fastened to the ties by sixpenny nails. Their failure has been due almost exclusively to splitting after five or six years service. Some of the plates were also worn or abraded. While they protected the ties as long as they remained intact, they did not prove as efficient as was expected. In 1907, about 500 creosoted white-oak tieplates 6 x 7 x ¼ in., averaging ½ lb. of creosote each, were laid on a test track of the Northern Pacific Ry. in Montana. These were all removed in August, 1910. In service these plates soon split badly and worked out from under the rails, and they also cut into the softwood ties.

Creosoted Wood Tieplates Proved Unsatisfactory on Western Railroad

Creosoted wood tieplates were used extensively at one time on the Gulf, Colorado & Santa Fe Ry., but the results did not come up to expectations. The plates furnished were not all applied, as their replacement with steel plates was soon begun. That the results were somewhat unsatisfactory, however, is attributed to inadequate attention to the manner of carrying on the experiment. The main defect, and the one considered responsible for failure, was the omission of means of seating and fastening the plates properly. Unless the ties are adzed to give recessed and level bearings in which the plates may be inserted, the latter are likely to split and shift. At first they were secured only by the track spikes, but as they showed a tendency to creep in the direction of rail, each plate was afterward fastened to the tie by two small nails.

On this road the wood plates were regarded as a temporary experiment, and it was estimated that their life would be only a quarter to a third of that of steel tieplates. Furthermore, they were not advocated for main-line track carrying heavy traffic. But for branches and lines of medium traffic it was considered that if hardwood plates were inserted and fastened on ties properly adzed to receive them they would much more than pay for their cost by preventing the rails from cutting the ties. The cost of the plates in the track was about 1c. each, as compared with 0.6c. for those of the Cleveland, Cincinnati, Chicago & St. Louis Railway.

Distribute Subway Track Material by Motor Truck

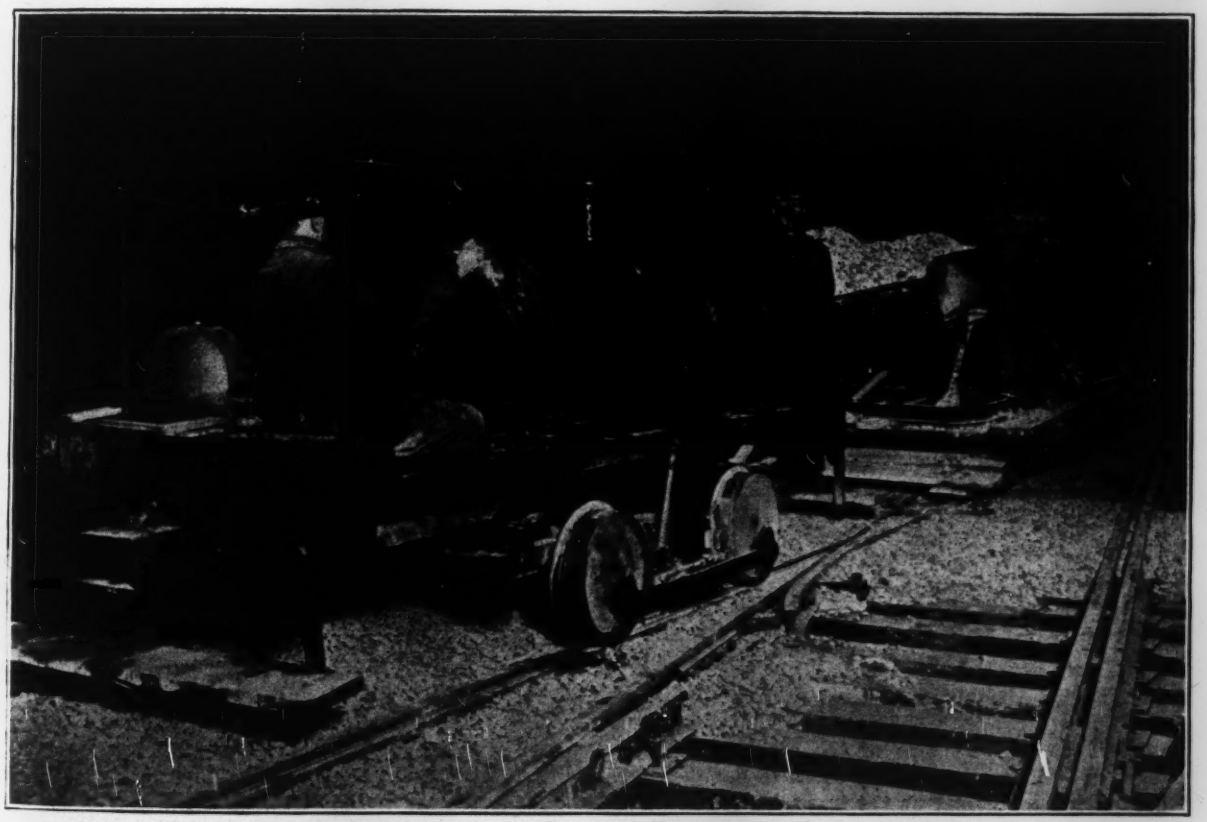
Lay Track in Seventh Avenue Subway, New York City, First, Then Dump Ballast From Home-Made Cars Pulled at 15 Miles an Hour by Kerosene Dinkies

THE MOST rapid subway track-laying work yet done in New York City has been recently completed on the Seventh Avenue line of the new dual system, by the simple expedient of distributing track materials first, laying the track, and using it to transport the stone ballast. The track materials were put down chutes made of ties and plank in ventilator openings, and distributed by a pair of motor trucks running on the concrete subgrade. As fast as unloaded from the trucks they were piled on the duct benches and to the sides, leaving the concrete subgrades free for the operation of the trucks until all of the track material had been carried to place. The stone ballast was dumped from motor trucks into bins constructed in ventilator openings at nine points along the 7-mile route, was drawn into home-made cars built for the job, from which it was spread over the tracks while running at full speed. The tracks were raised with jacks and tamped in the ordinary way. The contract, which was awarded Nov. 2, 1916, and on which work was not well started until Dec. 1 of that year, was practically completed by Dec. 1 last. The Interborough Rapid Transit Co. also let to the same contractor the installation of the third rail, which kept the forces of the contractor partly busy for some time longer.

The track laid under the contract, except at stations, is that designated Type Q by the Public Service Commission, consisting of 100-lb. rail in 33-ft. lengths, with 2-ft. continuous rail joints on wood ties to which the rails are spiked through tie-plates. The ties are 6 x 8 in. embedded in 14 in. of stone ballast. The third rail being installed is the heavy 150-lb. section. The track at stations, known as type 11, consists of 30-in. creosoted ties embedded in concrete.

The work consisted of laying two local and two express tracks from Times Square, where they connect with the old subway, through Seventh Avenue, Varick Street, West Broadway and Greenwich Street to South Ferry, where the line again connects with the existing subway. This is known as the "U" line, and from the Chambers Street Station to South Ferry there are only two tracks. Just south of Chambers Street the inside express tracks go beneath the outside local tracks and turn east through Park Place and south through William Street to Old Slip. This is known as the "V" line. From Times Square to the Pennsylvania Station there is a fifth track, making in all a length of 29 miles of single track.

As previously stated, the ties and rails were shot into the subway by means of chutes constructed of ties and



PLOWS ENABLED TRAIN TO DUMP BALLAST WHILE TRAVELING FIFTEEN MILES AN HOUR

plank and placed in ventilator openings. They were distributed by automobile trucks running on the concrete invert, and piled on the duct bench and between the steel columns. This left the invert free as long as desired for the use of the trucks.

The ties were hauled in motor trucks to various points along the line and shot down chutes in ventilator openings located at Rector, Beach, Bedford, Eighteenth, Thirty-sixth and Forty-first Streets and Maiden Lane. The ties were then loaded on the motor truck in the subway and hauled to a point midway between chutes, so as to work toward the chutes, and piled along the sides on the duct bench. About 100 ties constituted a load. All the handling of the ties was done by hand.

The rails were taken in at only three points, one at Beach and Varick Streets, where a 15-ton derrick was used, at Eighth Street with a 10-ton derrick and at Thirty-eighth Street and Seventh Avenue, where a steel chute, constructed out of 24-in. I-beams laid flat, was employed. The rails were hoisted from the pile to position in the chute with a runner line and slid down with a tag line attached. This method was about twice as fast as handling the derricks, which average 15 rails per hour.

The rails were loaded on the motor truck by two 1½-ton chain hoists suspended from two 15-ft. derrick booms with 4 ft. masts guyed to the truck. One hoist was suspended from each side so as to load two rails at a time and to keep the truck balanced. One ton truck carried 12 to 14 rails at a time. The other truck, a 3½ tonner, carried 10 rails at a time. On account of the heavy loads rubber dabs were placed under the springs. They saved considerable trouble.

Ballast Dumped With Trains at Full Speed

Practically all the track material was distributed before the assembling was begun. After the assembling and bolting the ballasting was begun. The stone ballast was unloaded from stone barges by a clamshell and dumped into a hopper alongside of the barge on the dock. Both motor and horse trucks drove under the hopper and were loaded by gravity. The ballast was then hauled to the subway and dumped into bins constructed in ventilator openings, from which it was loaded by gravity on ballast trains. These bins were located at nine points. The ballast trains were hauled by Bell kerosene steam locomotives weighing about 7 tons. These locomotives use very high pressure steam and the driving power is developed by a high speed engine running in an oiltight case geared directly to the axle. The fuel cost for these locomotives is given at less than 1 cent per ton mile hauling and spreading ballast.

The ballast cars were made by dismantling twelve Koppel cars and substituting heavy standard-gage axles for the old ones. The distance between axles was changed, and a pair of axles built into a wooden platform car, six of which were made. Upon each of these were mounted the bodies of two of the dump cars. These were placed with bodies set so that they would dump on the opposite side of the car. Four of the cars were built with bodies set so as to dump directly over the ends of the car on the track, while on two the bodies dumped over the side. A train was made up with two end dumping cars and one side dump car.

The ballast was discharged while the train was going at full speed and to keep the train from derailing plank plows were constructed on the front and rear of each car. These plows were controlled with a lever operated by a man on each car. They consisted of a 3-in. plank with a beveled edge which could be held very close to or in contact with the rails. These plows worked so well that it was possible to spread stone when the train was going at 15 miles per hour. This method of handling the ballast proved to be very efficient, and it was possible in eight hours to handle from 250 to 300 cu.yd., the best record about 400. On the lower part of the "U" line on account of the heavy traffic it was decided to haul ballast at night. The best run here was about 340 cubic yards. Three and four automobile trucks were used to haul ballast from the dock. After the track was ballasted the tracks were raised, tamped, lined and dressed. This was done by hand.

Track at Stations Laid in Concrete

The material for the track at stations was shot into the subway and was placed on the station platforms, which were complete except for the 3-in. finish. The concrete material was dumped on the street and shoveled into a chute which conveyed the material to the station platform where it was stored. Two methods of concreting were used. In one the portable mixer moved along the platform and concrete was spouted to the track. The other method was to place the concrete mixer on a car on the track next the one to be concreted, moving it along as desired. In both cases the mixer was fed by wheelbarrow. This track was supported during concreting by an 8-ft. tie which in turn rested on concrete blocks. The ties were held in place by means of 1 x 2-in. longitudinal strips. The 8-ft. ties were sawed in the middle and removed just ahead of the placing of the concrete. One gang consisting of one foreman and about 12 men could line and surface about 250 feet of track a day. On account of the exact alignment it was slow work, no variation of more than ¼ in. being allowed. As fast as the track was ready the concrete was placed.

The average haul for track material in the subway was 5000 ft., and for ballast was considerably shorter on account of the many points to which it was possible to deliver it. The average haul on the surface for track material and for ballast was about one mile.

There was scarcely any trouble in operating the motor trucks underground. The only obstructions encountered were temporary air pipes at different points where the subway work was not quite completed. The worst conditions of this kind occurred at Pennsylvania Station, where low plank bridges were placed for the trucks over these pipes. One of the trucks was run down the stairway incline under its own power at Thirty-third Street before the treads were placed. The other was lowered into the subway at Beach Street by a derrick. Both were removed by this derrick.

The Interborough Rapid Transit Co., which is to operate this subway, let to the same contractor the installation of the contact rail. This rail was lowered into the subway by the derrick at Beach Street and first piled next to the steel columns, about 60 rails being piled

at a time. This rail was loaded on a rail car with a 1-ton chain hoist suspended from a beam. The third rail was distributed where needed and placed on porcelain insulators by hand. The rail-car was made with extra wheels left when the ballast cars were built.

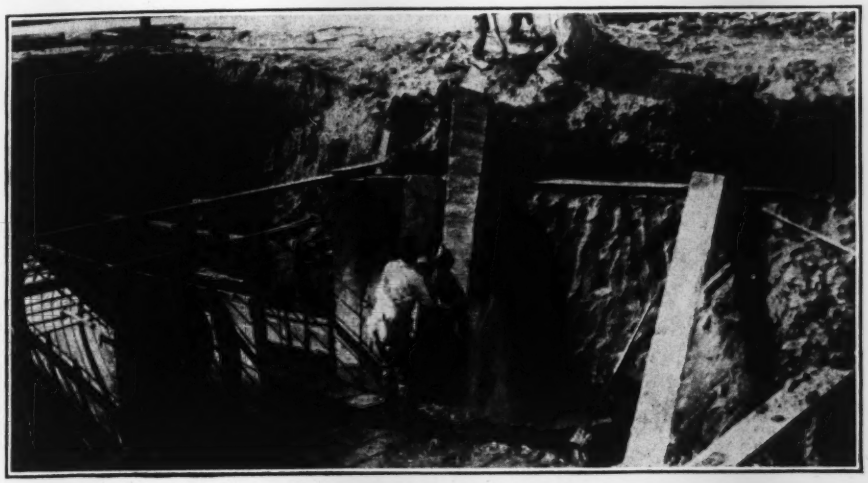
The average force employed was about 225 men. The best progress for one foreman and 15 men in a shift was about 600 feet of track ready for ballast.

The contract was carried out by Engel & Hevenor of New York City under superintendence of F. H. Gordon and the work was under the direction of the Public Service Commission for the First District, for which D. L. Turner is chief engineer of subway construction, Robert H. Jacobs is division engineer in charge of track construction, and Edward Niemann assistant engineer in immediate charge of this work.

Warped Concrete Surface Built by Unit Construction Method

Transition Surface from Pipe to Canal Section Made Up of Series of Narrow Pre-Cast Slabs

A WARPED concrete surface was built up in sections in constructing the outlet from pipe to canal section on one of the siphons of the South San Joaquin Irrigation District in California. Forms for the entire warped surface on each side of the canal were first built up in a single piece and then sawed in two pieces so that they could be laid on the ground and the concrete poured conveniently.



CONCRETE SLABS 12 IN. WIDE AND VARYING FROM 7 TO 15 FT. LONG ARE SET UP AT PIPE LINE CANAL TRANSITION

AND MAKE THE WARPED SURFACE CONNECTING THE TWO PARTS OF THE IRRIGATION LINE SHOWN IN THIS VIEW

The forms were marked off so that alternate slabs could be poured, 4 x 12-in. in cross-section and in lengths varying from 7 to 15 ft. The intermediate slabs were poured later, using building paper between slabs. Two longitudinal bars of ½-in. steel were placed in each slab with three short crossties. When the slabs had set they were very easily put in place, one at a time, and held in position by falsework until the joint with the floor section could be grouted and a tie beam cast along the top to tie the several units together. At the bottom each slab ended in a blunt wedge which fitted into a shoulder provided in the end of the concrete floor slabs. The floor slabs were also laid on

Wartime Demand for Northwestern Lumber

Ten million feet of selected spruce per month is the rate of production for airplane stock from the Pacific Northwest. This record has been established under the direction of the spruce production division of the United States Signal Corps. Wooden ship construction is likewise receiving first attention from producers, according to *Dun's Review*. In addition to supplying wood for the vessels under construction in Northwest yards, there have been shipped east and south in recent months 40,000,000 feet of ship timbers.

the unit plan basis because flowing water interfered with casting concrete in place. These were made 6 x 24 in. in cross-section and from 2 to 7 ft. in length so as to stagger the longitudinal joints.

No attempt was made to plaster the cracks between slabs, and as a result the finished job had a rather rough appearance. The object of the transition section, however, was to cut down the loss of head in discharge and this was accomplished sufficiently by the warped surface so that the additional expense of plastering was not considered necessary.

The chief item of expense in these warped surfaces is the cost of formwork. This is simplified by the use of the unit construction method, but even this is considered of doubtful economy unless the same form can be used a number of times. The formwork for the warped surface to be cast in unit blocks is just as intricate as the formwork built in place, and the saving on a single job would be negligible if the wall does not have to be back formed.

R. W. Olmsted is chief engineer of the South San Joaquin Irrigation District.

Modern Drawbridges Attain Great Weights and Spans

Three-Truss Keadby Bridge—Chattanooga Bascule Is Heaviest—Single-Leaf Draw of Record Length Being Built

THE recent completion of a very heavy bascule bridge over the Trent River, at Keadby, England, carrying the traffic of the Great Central Ry. to the Immingham docks, supplements the list of notable drawbridges by the heaviest single-leaf Scherzer rolling-lift bascule yet built. There are longer single-leaf Scherzer spans, and both longer and heavier two-leaf spans.

The Keadby bridge consists of a leaf 160½ ft. long between main bearings and 63½ ft. wide. Including counterweights, it has a total weight of 6,325,000 lb. The structure has three trusses; on one side is a double-track railway line, and on the other side a 20-ft. highway. The center truss carries almost one-half the total moving weight, or 3,000,000 lb.

The longest single-leaf Scherzer span is the double-track crossing of the Baltimore & Ohio R.R. over the Cuyahoga River at Cleveland, Ohio. Its span is 200 ft. between main bearings. Span and counterweight total 5,250,000 lb.

The bascule span of the Tennessee River bridge at Market St., Chattanooga, Tenn., completed last year, is the longest and heaviest two-leaf rolling-lift span; it also has the remarkable feature of acting as a three-hinged arch when closed. The span between main bearings is 310 ft.; the deck has a 36-ft. roadway and two 6-ft. sidewalks. The total weight of leaves and counterweight is 9,000,000 lb. The designers call attention to the remarkably low weight of the machinery, there being only 46,000 lb. of machinery in all, and each leaf being operated by a single 25-hp. motor. The bridge has been successfully operated by hand power.

Bridges of the other bascule type most widely used, the Strauss trunnion bascule, have reached longer spans, and, except for the Chattanooga bridge, slightly greater weights.

The longest single-leaf Strauss bascule is one now being built to carry the St. Charles Air Line Ry. over the Chicago River at 16th St., Chicago, Ill. This will have a span of 260 ft. from center of trunnion to center of end bearing. Its weight will be 7,100,000 lb., including the counterweight. It has two through trusses spaced 32 ft. 4 in. between centers. The operating machinery will weigh 139 tons, including two 150-hp. electric motors.

The heaviest single-leaf Strauss bascule bridge, and the one of longest span now in operation, is that of the Baltimore & Ohio R. R. over the Calumet River at South Chicago, which was completed in 1914. The span is 235 ft. from center of trunnion to center of end bearing, and the weight is 7,600,000 lb., including the counterweight. It is a through bridge with two trusses spaced at 31 ft. 3 in. centers. For its operation there are two 140-hp. electric motors, and the weight of machinery is 125 tons.

The longest double-leaf Strauss bascule bridge is that carrying the Canadian Pacific Ry. over the U. S. Ship Canal at Sault Ste. Marie, Mich. This was also completed in 1914. It has a span of 336 ft. between trunnions, and is a through bridge with trusses spaced 20 ft. centers. The weight, including counterweight, is 7,500,000 lb. The operating machinery weighs 138½ tons, and includes four 40-hp. electric motors.

The heaviest double-leaf Strauss bridge, however, is the Palace bridge over the Neva River at Petrograd, completed in 1915. This weighs 8,400,000 lb., including counterweight. Its span is 208 ft. 8 in., and its width 91 ft. 3 in., with eight lines of through trusses. It carries a highway and electric railway. There are four 40-hp. electric motors. The weight of machinery is 455 tons. This includes machinery necessary to relieve the load of the counterweight from the counterweight trunnion when the bridge is closed, so that the bridge in this position will act as a three-hinged arch.

Vertical-Lift Spans

Some noteworthy figures have been attained by vertical-lift spans, according to figures given by Waddell & Son, consulting engineers, New York.

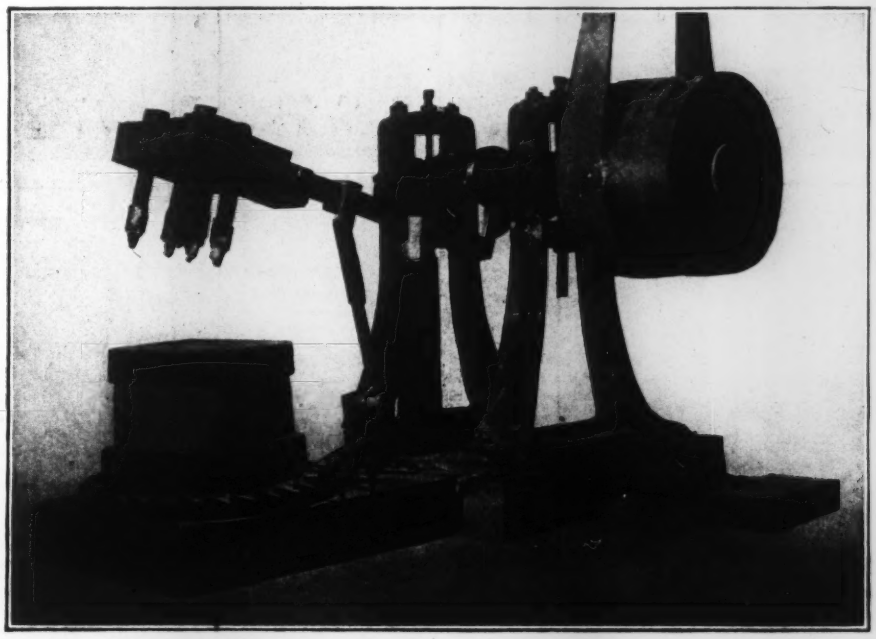
The longest vertical lift span is on the Great Northern Ry., crossing the Missouri River in Montana, 296 ft. long, center to center of end pins. The heaviest is the Willamette River Bridge of the Oregon-Washington Railroad & Navigation Co. at Portland, Ore., which with 220-ft. span has 4,300,000 lb. of moving weight. This bridge has two decks, the lower of which has a separate lifting arrangement by which clearance for ordinary vessels is obtained without lifting the entire span. Of ordinary lift bridges, i. e., without separate lifting deck, the Pennsylvania R.R. bridge at Chicago with span of 272 ft. 10 in. and a moving weight of 3,000,000 lb. represents the maximum.

While not, strictly speaking, a lifting span, the Fratt or Armour-Swift-Burlington bridge over the Missouri River at Kansas City, Mo., should be mentioned on account of its great length of span, 428 ft. The lifting part here is the lower deck only; the truss span, which is set at a higher elevation, is fixed.

Wear-Resisting Values of Various Aggregates for Concrete Roads Indicated

New Machine Generates Impact Stresses Which Closely Parallel Those Set Up by Traffic, Whether Horse-Drawn or Motor-Driven—Tests Made on Paving Brick Furnish Interesting Results

By H. S. Mattimore
Engineer in Charge of Physical Testing, New York State Highway Commission, Albany.



While definitely applicable to concrete intended for structures where compressive strength is the controlling factor, compression tests have proved to be inadequate as a guide in selecting aggregates for concrete road surfaces, and need to be supplemented by tests which will indicate resistance to impact and abrasion. It is true that there are standard tests of these natures, and that methods have been devised for making abrasion tests on sand. But such "unit" testing of aggregates furnishes no true measure of their value when these aggregates are combined in concrete. This has been generally recognized, and many experiments have been made with the intent of establishing methods of testing the essential resistance of concrete when subjected to the destructive effect of road traffic.

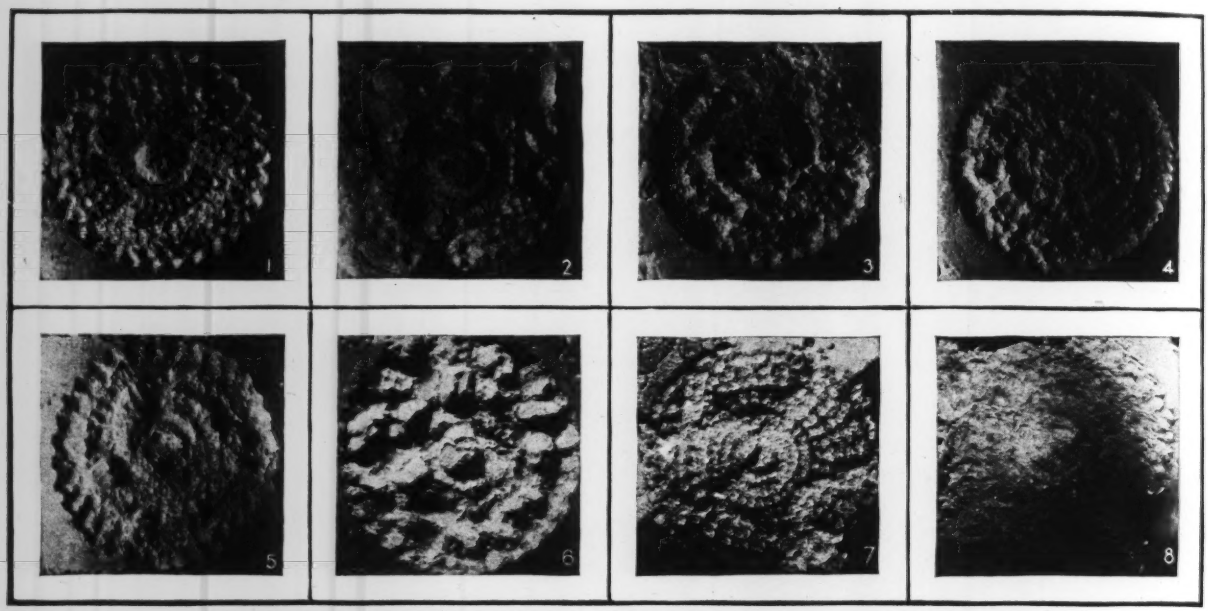
Experiments with several methods have been carried on for the past several years in the laboratory of the New York State Highway Commission. Originally two separate machines were employed—one abrading the specimen, the other subjecting it to impact stresses. A number of specimens were made in the field and cured under approximately the same conditions as the concrete being placed in the road surface. Tests were run on these specimens and, at the same time, investigations were made of the road surface to ascertain, if possible, the value of the test indications.

The results of the tests made with the abrading machine were of little comparative value, as the resistance of the specimen as a whole depended entirely upon the hardest aggregate—for a hard, coarse aggregate will support a poor matrix, or vice versa. Furthermore an inspection of road surfaces to determine the effect of traffic has convinced the writer that, although there is some wear due to abrasion, this is of secondary importance when compared to the severe impact effect of horsedrawn and motor vehicles.

Such impact effect as is traceable to the motor truck is the result of an irregularity of wheel circumferences caused by imperfect or worn tires, or because of the use of chains or other anti-skidding devices. In a number of instances the effect is due to irregularities in joints or cracks in the road surface. While it is true that the abrasive action of the traffic accelerates the destruction, the non-uniformity of wear is, in the majority if not all cases, started by impact rupturing the surface in weak spots. Rupture once started, the surface becomes rough, the intensity of the action increases and the number and sizes of the holes develop rapidly. This unevenness, in conjunction with frost action and subgrade settlement, is responsible for the failure of not only concrete roads but all highways of a rigid type.

In line with the opinion held in this laboratory, that impact is the most severe traffic stress which pavement must resist, the machine shown in the accompanying

illustration was designed to furnish a test that would parallel and accelerate the effect of traffic. The principle underlying the design is simple, but it may be well to call attention to what are considered its main advantages. First, the test area lies entirely within one surface of the specimen, and therefore the effect of aggregates. Third, the table upon which the specimen rests is continuously revolved by means of a dog attachment, so that the blows of the calks follow in nine concentric circles approximately ¼ in. apart. The total effective weight of the head is 29 lbs., the blows being delivered at the rate of 100 per minute. The machine

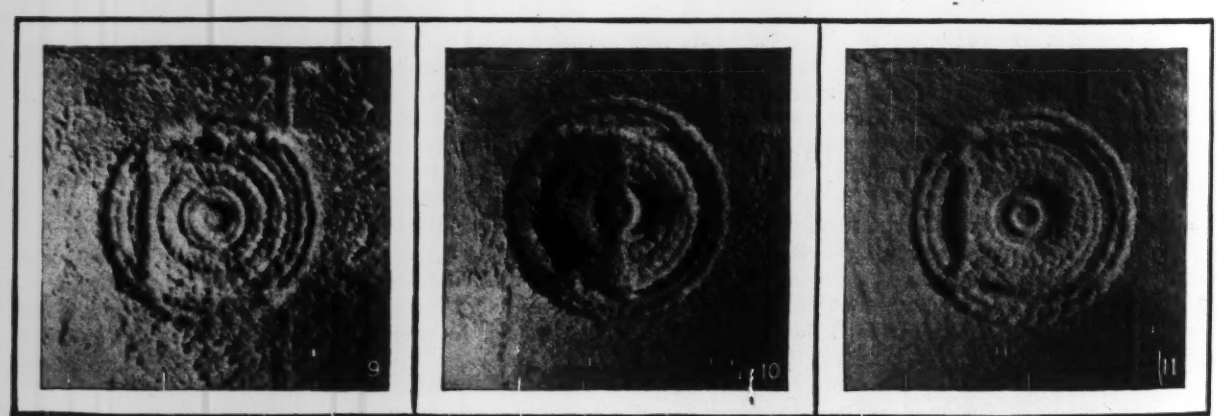


MACHINE PRODUCES WEAR MUCH LIKE THAT NOTICED ON ROAD SURFACES

(1) A 1:2:4 mix of traprock and an excellent quartz sand in which the large traprock aggregate has carried the wear. (2) A 1:1½:3 mix of quartz gravel and a good quality of sand, composed mostly of sandstone, a small percentage of quartz and tough shale. (3) A 1:1½:3 mix of a good limestone and a sand composed of quartz and granite grains. The limestone wore almost as fast as the matrix. (4) Same as first illustration as to aggregate, though the mix was 1:1½-3 and the wear was more uniform because of this. (5) A 1:1½:3 mix in which the coarse aggregate was a gravel composed of sandstone, quartzite and a small percentage of shale. The difference in wear due to the difference in aggregate is noticeable. (6) A 1:1½:3 mix of an excellent quartz gravel and sand, showing the spalling of the quartz and the lower wear of the larger pieces. (7) A 1:1½:3 mix of traprock with a five-grained quartz sand which resulted in a weak mortar, as might have been expected. (8) A 1:1½:3 mix of soft limestone with the same sand used in the second specimen. Specimens of this composition wore rapidly but uniformly, the mortar seeming to possess the same resistance as the coarse aggregate.

shear failures at weak corners or joints is eliminated. As a further assurance against such a contingency, a steel band is used to protect edges and corners. Second, there are nine hitting points, each armored with a non-slip horse calk. Furthermore the blows act through springs which allow a ½-in. play, thus partially compensating for such irregularity of surface as may be due to the unequal resistance to wear of the different as illustrated accommodates a 6 in. cube but can readily be changed to take a 6 in. x 12 in. cylinder, thus permitting the use of ordinary test specimens cast in the field for compression test.

Some several hundred tests have been run on concrete made from various aggregates and mixes. A number of these specimens were made and cured in the field, while others were made in the laboratory, where more



SOME TESTS WERE MADE TO DETERMINE THE ACTION OF THE MACHINE ON PAVING BRICK

(9) Wire-cut shale brick, all of uniform quality. (10) A mixture of normal, underburned and overburned shale brick. (11) Repressed fire-clay brick all of normal burn.

complete control could be maintained over consistency and mixes. Furthermore it is our intention to test specimens taken from concrete roads which have been subjected to traffic for several years in order to secure accurate data for future specifications.

The cement used in all the specimens shown in the accompanying pictures was either from a shipment which met standard specifications, or in the laboratory mixes a blend of several standard brands. No effort was made to test quality of different brands or types of brick—the illustrations are given to show the action and effect of the machine rather than to determine quality.

The definite conclusions that may safely be drawn from the results of this test in its present stage are:

(1) Crushed stone remains intact and resists impact better than gravel; (2) large size stone and gravel are more durable than the small sizes; (3) the resistance to impact depends upon the quality of both the mortar and the coarse aggregate and, although a good matrix has a tendency to support a weak coarse aggregate, the use of a good quality of the latter will make a more durable pavement; (4) a coarse grained sand mortar resists impact better than a mortar made with finer grained sand, and (5) no relation has been observed between compressive strength and resistance to impact.

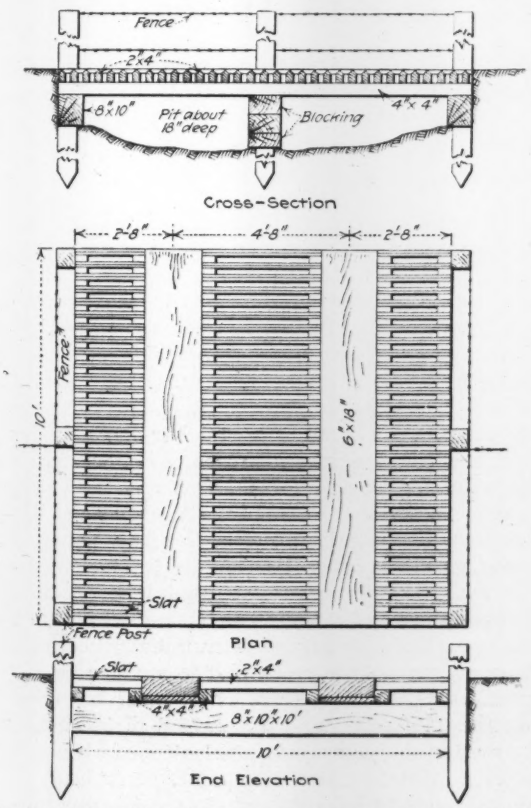
As would be expected, an increase of cement content increases resistance to wear, but with a proper selection of aggregates of excellent quality a 1:2:4 mix can be made which will offer a better resistance to impact than a poorer quality of aggregate mixed 1:1½:3.

The machine was designed in the New York State Laboratory under the writer's supervision. Credit for its design and perfection is due F. H. Rood, J. L. Herber and P. E. Bermel of the laboratory, who spent some part of their time developing the idea in its relation to pavement testing. The original intention was to devise a method for testing concrete, but the machine has been found applicable to shale and clay block and there is every reason to believe that the principle may be adapted to any type of rigid pavements.

Guards and Gates Keep Cattle Off Roads

CATTLE-GUARDS in highways, to keep cattle off the road and yet leave free passage for automobiles, have been used in San Bernardino County, California. As described by H. L. Way, deputy county surveyor, they are of the pit type once common on railways, and are 10 ft. square, over a pit about 18 in. deep. End sills and a center support of blocking carry two planks 6 x 18 in., spaced 4 ft. 8 in. on centers. These form the track or wheelways. Parallel with them are sticks to which are nailed cross-slats having beveled tops so that they afford no foothold. For horse-drawn vehicles there is a parallel strip of road closed by a gate.

Automatic gates have been provided for a similar purpose at many places on mountain roads, where the sidehill slope is too great to admit of the double roadway noted above.



CATTLE-GUARD IN HIGHWAY GIVES FREE PASSAGE FOR AUTOMOBILES

Natural Gas Shortage Speeds Up Hydro-Electric Development

Many of the industries of western Ontario using natural gas as motive power are seriously menaced by a falling off in the supply. The Union Natural Gas Co. notified consumers in Chatham, Windsor, Walkerville and several adjoining municipalities that after the middle of December the supply of gas for power purposes would be discontinued. The manufacturers affected appealed to the Ontario Hydro-Electric Commission and their necessities have greatly increased the already urgent demand for additional power. As an emergency measure the commission has decided to proceed at once with the construction of extension to the plant of the Ontario Power Co., which it recently acquired, involving an expenditure of over $1,000,000. This will make 25,000 additional horsepower available in July next and another 20,000 hp. within about 10 months from now.

Contracts will be let immediately for a 13-ft. wood-stave pipe from the river to Queen Victoria Niagara Falls Park, down to the development at the foot of the falls. This pipe will enable the Ontario power plant to be developed to its full capacity, producing an extra 25,000 hp. Enough water will also be provided for additional generators, and tenders will be let for the installation of additional turbines, with penstock and generator complete.

Work on the Chippawa Canal is being carried on by a force of 500 men, and an electrical shovel equipment will be installed by the first of the year. The Chippawa development is expected to furnish 3,000,000 hp. and will cost about $23,000,000.

Review of Prospects for Railway Maintenance and Improvement Work in 1918

Government Restrictions May Be Relieved with Passing of Railroad Bill, but Labor Shortage Is Regarded as Most Serious—Supply of Engineers Also Inadequate, Materials Costly and Delivery Uncertain

RESTRICTION of railway maintenance and improvement work during 1918 is indicated by a recent extended inquiry made by a representative of *Engineering News-Record* as to the present outlook for such work. It is indicated also by the remarks and discussions at the March convention of the American Railway Engineering Association. This restriction is applied in two ways. It comes directly through orders from the Government requiring reduction of expenditures and of work pending direct authority for individual projects. It comes indirectly also, but with equal force, from the conditions of high prices and uncertain supply in both the material and labor markets. The first condition promises to be relieved somewhat under the provisions of the new railway bill, with its large appropriations.

Proposed expenditures for improvements costing more than $25,000, however, must be submitted to the Director-General of Railroads for approval, as noted in *Engineering News-Record* of Apr. 4, p. 682. It appears likely that these projects will be scrutinized closely as to their importance and necessity. For example, track elevation in one city has been approved for the reason that work has progressed so far as to cause serious interference with street traffic, while similar work in another city has been disapproved since it has not been started and there is no such urgent need for it.

Additions and Betterments Likely To Be Limited

The following review of the situation, in various aspects, is based upon information from engineers representing nearly 40 railways having from 300 to 10,000 miles each, and aggregating nearly 100,000 miles of line.

As far as rail and tie renewals are concerned, a large majority of railways plan a normal amount of work in 1918. Some have planned an excess amount because of the reduction in such work during the past two or three years, and the necessity of bringing the property up to normal condition. In most cases the statements are qualified by the admission of probable difficulty in carrying out the program, on account of the conditions as to material and labor. Double-tracking, additional passing tracks, yard and terminal extensions, new water and coaling stations and such other facilities as come under the classification of additions and betterments are likely to be limited and few roads appear to be planning extensive programs for work of this kind.

Speed restriction is one step advocated as desirable under present conditions, the maximum limits suggested being 50 and 35 m.p.h. for passenger and freight trains respectively. The purpose of this is to reduce wear and renewal of track, locomotives and cars; also to reduce the chance of derailment and damage done in case of such accident.

As to bridges the impression is that in many cases it will be difficult to do more than the work necessary to maintain structures in serviceable condition. Maintenance and repairs must be looked after, but renewals will be limited, and special attention given to avoiding steel work. One road reported a large program, with an estimate of $400,000, but this was before the requirement was announced for the submission of such programs for government approval. Another road will place six bridges that were ordered in 1915, thus bringing all its bridges up to the E-60 loading. In many cases the bridge inspections have been made with special care. Then the estimates have been checked rigorously and all work cut out that is not absolutely necessary. Under the present emergency conditions many engineers may find opportunities for the strengthening or reinforcement of steel structures to increase their life or even to provide for heavier loading.

In some cases timber structures needing renewal are to be rebuilt in timber instead of being replaced with steel, but the shipbuilding demands may make it impossible or difficult to obtain the larger sizes of timbers for such work or for the repair of existing structures. Even the filling of trestles is mainly limited to those that must be either replaced or repaired. A few roads, however, propose extended programs of work on concrete arches, trestles and culverts to replace timber trestles. Conditions are considered favorable in many ways to the wider use of concrete structures, large and small. This will mean greater expenditures for a time, but will result in a conservation of timber and in more permanent structures, with decreased annual cost of maintenance and renewal.

Engineering Forces Depleted

In spite of the reduction of work, there seems likely to be a shortage of engineers for railway service. Draft and enlistment for military service and the opening of extensive fields of employment on building construction, shipbuilding and the like for the Government and for industrial concerns have made serious inroads upon the engineering forces of many railways. How serious this is on any road depends not only upon the loss of men but also upon the amount of work being done. Railways that have little present or prospective work may get along with the reduced force. The general condition, however, is a shortage of supply. On some roads this is experienced particularly in regard to field assistants and rodmen; on other roads it is mainly in office men and draftsmen. Several roads state that they can fill the higher positions by promotion or by employing men who are over draft age or exempt from military service.

It seems generally more difficult to get draftsmen and rodmen, especially where the latter must be technical graduates. This shortage is expected to become more serious after the next draft. Valuation work has been interfered with by these conditions, there being difficulty in maintaining sufficient field and office forces. One road that has had trouble in getting sufficient

draftsmen for the work has suggested that the Government, as represented by the Interstate Commerce Commission, might relieve the situation by allowing prints of existing maps and drawings to be filed, instead of requiring new tracings in all cases. This permission has since been granted by the Commission.

Many roads are short of rails, frogs, switches, tie-plates and track fastenings, and find it difficult to replenish their stock or obtain material for ordinary requirements. Rail renewal is a very necessary and important feature in keeping the lines in proper condition for heavy traffic, and Mr. McAdoo, director-general of railroads, has called for information from the railways in regard to their work. This is to include the amounts laid in 1917, left over or on hand, ordered for 1918 delivery, and required for maintenance and construction in 1918; also the minimum amount considered absolutely necessary to maintain track in safe and proper condition during 1918.

Supply of Track Material Uncertain

Shortage of rails has not been experienced as yet on some roads which placed large orders a year or two ago, as their material has been laid or is being delivered. But even here the outlook is doubtful. Where orders have been placed well in advance the deliveries have been slow, uncertain and not up to contract in time or quantity. This is due largely to priority given to orders for U. S. Government work here and abroad. In one case rails to be delivered in 1917 were two months late, and after a few weeks of intermittent delivery the shipment ceased. As a result, rail renewal was done on only half the expected mileage, the balance being left for 1918. Deliveries for 1918 are in some cases expected to come too late for use, or to be deferred until 1919.

In several cases rails ordered for the 1917 program could not be laid, owing to late deliveries and shortage of labor. These are now on hand, but the labor situation makes it doubtful whether even these can be laid. There are many cases where rails must be renewed if the tracks are to be kept in condition for heavy traffic. Similar conditions exist, but generally to a lesser extent, in regard to frogs, switches and track fastenings. Delays are not so long as with rails, but where these supplies are to be used in connection with certain rail-renewal work their early delivery does not advance the work. Under these disturbed and uncertain conditions it is difficult to plan a definite program, and attention must be concentrated upon any weak points.

Delay in renewing rails on main line generally reacts on the subsidiary lines. Ordinarily when new rails are laid in main track they release lighter rails as "relayers" for branch lines and passing sidings, and these in turn release still lighter rails for yards and industry tracks. Light and relayer rails are not now easy to obtain in the open market.

A considerable amount of main-track renewal is due to rails being bent and worn at the ends, so that they make a rough riding track. On several large railways this condition is being met and the life of rails in main track increased by the application of special devices or splices either to raise the joints or to keep the rail ends from becoming depressed. Raising of joints and then grinding of the rail ends to a uniform plane and a level surface, as is done on street railways, has been suggested as of possible application to railway track.

Rail as Good as Usual

The investigation included inquiry as to whether there is trouble with the quality of rails, or difficulty in getting them made to railway specifications. The replies are generally in the negative, though qualified in some cases by the statement that there is no more trouble than usual. In two cases considerable trouble from broken rails is experienced, the type of section being held partly responsible. One of these refers specifically to the 85-lb. A. S. C. E. rail, where breaks in the base are attributed to seams in the light base of this section.

Poor quality of rails is noted by four roads, all of which operate heavy traffic and loads. Two say that the heavier rails now used are less serviceable than the older and lighter rails, the trouble being in soft metal that flows and mashes under traffic. Another says that during the past two years the openhearth rails have a tendency to flow under traffic, especially in rails on the low side of curves, this being due to soft metal in the top of the rail head. The third road states that the quality of steel might be better, but that this road's purchases are not large enough to permit it to dictate specifications. It purchases rails under the Manufacturers' Specifications, modified to the extent of requiring at least 9% cropping of the blooms, and more if necessary to get a good rail. The fourth reply merely states that rails are unsatisfactory as to quality.

Treated ties are used by 23 out of 29 railways as a means of insuring good and economical track. Three of these report that such ties are used exclusively, and the others range from limited to extensive use. Several roads state that from 20 to 80% of annual renewals are made with treated ties. One is using them mainly in side tracks. As to ties treated at railway plants, three roads state that in 1917 their output was below normal. The three reasons given are the drafting of the chemists, the high cost of chemicals and the shortage of ties cut.

The six roads which report that treated ties are not used get their supply mainly from local sources. Two state that it is increasingly difficult to get good ties and that the prices are rising. Shortage in the tie supply is expected in some cases, due partly to floods in the Ohio and Tennessee rivers early this year, and partly to the serious shortage of labor in the territory where ties are obtained. Laborers have been attracted elsewhere by high wages, so that some of the tie companies are unable to get men to cut ties.

Labor Situation Most Serious

That the labor supply for section forces, extra gangs and bridge gangs will be very short this year is the almost universal opinion, and it is estimated that the forces on different roads will be only 25 to 70% of normal. In some cases it is difficult to get men even at high wages, and more than one road finds that high pay is accompanied by low efficiency.

A somewhat different view is to the effect that the railway labor problem is more a matter of excessive turnover, due to general demoralization, than a matter of actual shortage in supply. Many men work casually

on the track, but shift from gang to gang and from road to road, habitually quitting on pay day. It is suggested that if they could be held permanently and the forces then organized efficiently the supply probably would be sufficient. Another view is that under present conditions maintenance officials will give more attention to getting full efficiency out of their forces. Loss of time in shifting gangs from place to place may be avoided by careful planning of the work program; and loss of working time of the men may be avoided by having material distributed ahead of the gang.

Labor shortage is found mainly in section forces on some roads, and in bridge gangs on other roads. The latter case is accounted for by the great demand for skilled labor on shipbuilding, construction and industrial work, where pay is usually higher than on the railways. It is not unusual to have section gangs limited to one or two men besides the foreman, and two roads report that in some cases the foreman has no help.

The general labor shortage indicates two things—difficulty in carrying out normal work to maintain the track in proper and safe condition, and reduction in the amount of work desirable for such improvement of the property as rail and bridge renewals and the construction of new facilities. That this shortage of labor is the most serious factor in the problem of railway maintenance work is the almost unanimous opinion expressed in the returns.

How the Railway Labor Shortage Can Be Overcome

Opinions Indicate Need for Better Treatment of Men, Wider Use of Machines and Careful Planning of Work

AS STATED in the foregoing article, railway maintenance engineers regard the labor shortage as the most serious obstacle in the way of improvement work and maintenance work during 1918. This subject was discussed at the recent convention of the American Railway Engineering Association. That its importance is recognized is evidenced from the fact that a committee on economics of railway labor was appointed last year and made its first report at the 1918 meeting. It is significant also that two or three committees brought labor-saving devices and machinery for railway work to the attention of the meeting by means of lantern slides and moving pictures as well as by their reports.

In the investigation noted above the ideas suggested in replies to specific inquiry as to the remedy for the labor situation may be summarized as follows:

Permanent section forces should be built up, more attention being given to the comforts and social requirements of the men. Supply individual dwellings at section headquarters, which men may rent or purchase, thus acquiring a place to live and take care of their families. Too much reliance has been placed on floating and foreign labor, with detriment to the force and the work, but under present conditions the supply of foreign labor has been greatly reduced. The system of permanent forces for railway maintenance is almost universal in Europe, and has been introduced with success in this country by the Long Island and the St. Louis-San Francisco railways. A number of engineers refer to the advantages of this system.

Wages should conform to those paid in other lines of work, so that men will not be attracted away from railway service as has been the case in the past. Hitherto railways have not met the market price of labor, and their work has suffered in consequence. Mere increase in pay, without regard to the wages in other occupations, is of little benefit. As a corollary to the above, a uniform rate of pay is desirable, to check the propensity of the men to shift from job to job. In fact, uniformity of pay, hours and overtime rates have been recommended to the railway companies already by the regional director of railways of the central division.

With increased wages it is found in some cases that men will work less time or fewer days, so that no advantage is gained. They sometimes refuse to work overtime with extra pay, even on lines where traffic conditions are such that much of the work cannot be done in regular working hours. As a general proposition, however, it is highly undesirable to work men overtime, either by extra hours or by calling them out on Sundays. The growing tendency among the men is to resent such demands, and excessive, unnecessary overtime employment has been one cause of dissatisfaction with railway maintenance service.

Improved camps and living facilities, with more regard for the human side of life, will tend to attract and keep men. In temporary forces, however, there is always a certain element which is restless by nature and will not stay on the job.

Labor from local sources of supply is preferable, if it can be had, as it is generally more satisfactory than the supply from large cities. Special care should be given to selecting men over military age or otherwise exempt.

Importation of Mexicans and Chinese is advocated by four large railways. But this is checked by the new immigration law, with its head tax and educational requirements, and it is doubtful whether Congress could be induced to repeal or modify this law, even for the period of the war. While admitting this, some officials point out the advantages that would accrue to the railways and the farmers by thus supplementing the labor supply.

Small extra or floating gangs may be organized on divisions where the section forces are very small, but such a plan is to be regarded as a temporary expedient for special emergency only.

The introduction of more machinery and power-operated appliances is recommended to supersede hand labor and also allow more work to be done and more territory covered by a small force.

Heavier track construction, with treated ties and well-ballasted roadbed, is advocated, so that less maintenance and renewal work will be required.

Unnecessary work should be eliminated.

Several replies laid stress upon the desirability or necessity of showing more regard for the laborer as a man, instead of as a mere working machine or animal. This is directly in accord with what *Engineering News-Record* has been advocating for some time. To quote from one reply: "We shall never have satisfactory

labor for track or bridge and building forces in this country until we have men who take a personal interest in the railway on which they work and who form an attachment for the location and country in which they live."

The shortage of labor seems to be felt specially in the South. Formerly there was an ample supply of negro labor at low pay, but this has been greatly depleted by the exodus of labor attracted by the higher pay in the North and East. It has been suggested that by raising wages in the South this condition may be overcome to some extent, at least during the winter, although even higher pay probably would not attract labor to the South during the four months hot season.

The supply of native labor has been reduced most seriously by military service and by the great industrial activities incident to the war. Foreign labor has been reduced to a minimum by the great reduction in immigration coupled with an emigration of foreigners to join the armies of their native lands. Among such labor as is still available there is a state of unrest which makes it difficult to organize the men or to keep them at work. Making track maintenance a line of permanent employment, with good pay and attractive working conditions, will improve things materially. But this cannot be of immediate help, as it will take some time to devise the necessary system of organization and to train men into it.

It is a general occurrence that while one road is discharging men and gangs, another road is increasing its forces. It has been suggested that this condition may be improved by the establishment of central agencies or labor clearing houses under the direction of the railways. Thus the clearing-house would be advised of the coming release of labor on some roads and the demand for labor on others. In this way it would often be possible to transfer gangs intact from one road to another, thus maintaining their efficiency and saving time and money for the men and the railways. This would apply mainly to unskilled labor, but might include skilled labor to some extent.

Labor-Saving Devices in Trackwork

Use of machinery and labor-saving appliances is one obvious method of offsetting shortage of men, and this is being applied increasingly on many railways. With the larger machines, however, high cost and uncertain delivery may be unfavorable factors. As long as labor was plentiful and cheap, and relatively slight attention was paid to its efficiency, there was little incentive to expend money for machinery and appliances. But under present conditions there are large advantages to be seen in purchasing equipment of this kind and in increasing the efficiency of the men. That the net result of present trying labor conditions will be a benefit to the railways is the opinion expressed by the engineer of one large system.

Motor cars for section gangs and bridge gangs, and also for inspectors and roadmasters, are probably the most widely used machines. In the latter case they avoid the necessity of taking men from the gangs to drive the officials over the road on hand cars. In the former case they not only conserve the time and energy of the men, as compared with hand cars, but also enable a given number of men to cover a longer stretch of line. In combination with trailers they can handle materials and large gangs of men and thus to some extent replace work trains.

The larger machines in most general use are those for loading and unloading rails and timbers, light cranes or hoists for rail and tie renewals, ditchers, spreaders and locomotive cranes. A ditcher with air-operated dump cars will dispense with a large gang of shovelers. Locomotive cranes are used for a wide variety of purposes, such as hoisting, handling material, excavating with grab buckets or scrapers, driving piles and also handling scrap with magnets. Spreaders are used largely in connection with ballasting, filling and ditch work; also for snow removal. In relaying rails, a light gasoline crane with two or three men will, it has been shown, take the place of a gang of 12 to 16 men and do the work more quickly, besides eliminating the chance of injury to men in handling heavy rails. Such machines can be adapted to a variety of uses. Rail loaders and unloaders are reported to do 40% more work than where hand labor is employed.

Pneumatic tie-tampers seem to be the most widely used tools. They are employed mainly on open track, in connection with portable air-compressor outfits. One road proposes to use them in freight yards which are piped with air for testing brakes on the cars. Another suggests their use at interlocking plants, compressors being installed in the signal towers. Several machines used in maintenance work are:

Rail layers	Tie tampers
Rail loaders and unloaders	Rail drills
Steam shovels and scrapers	Screw spikers
Motor cars	Spike drivers
Ditchers	Spike pullers
Locomotive cranes	Snow torches
Spreader cars	Mowers
Weed burners and killers	Ballast shapers
Small concrete mixers	Ballast cleaners
Derricks and derrick cars	Portable saw rigs

Certain machines or tools have been suggested as desirable but are not yet available. These include devices for lining track, adzing ties, screwing up track bolts, grinding rail joints, renewing ties and loading snow. One road is developing a light track layer, as a step beyond the rail layer. The large track layers once used so extensively are applicable mainly on new construction and where considerable lengths of track are to be laid. One road asks for any information available as to a machine for tie renewals; that is, to take out and put in ties by mechanical power.

Devices of a special class are those for clearing snow and ice from track and switches. Besides the ordinary snowplows and flanger cars these include scrapers, flangers, portable torches and steam nozzles. Ice-cutter cars to loosen the packed snow and ice between the rails are a valuable adjunct to the snow plow, as the material may be too hard for the plow and gangs with picks make slow progress. Gas and electric heaters to prevent the accumulation of snow at switches and interlocking plants may save the work of an army of shovelers and warrant the high cost of such installations. Removal of heavy snow from yards, driveways and station platforms may be done to advantage with large scrapers operated by teams or light tractors.

Work-train service is necessary in much renewal and improvement work, as in ditching, distributing and collecting material, and handling extra gangs and bridge gangs. With the general shortage in supply of loco-

motives and cars for traffic, there is increasing difficulty in having equipment assigned for work of this kind. The difficulty may be mainly with locomotives or with cars, but very frequently it applies to both. Cars generally used in work-train service have been put into service for handling coal and lumber. One road having normally 1700 cars for ballasting and filling has its supply cut to 800 cars. Fuel shortage in some cases has been a factor in reducing the supply of work-train equipment. It frequently happens that such equipment can be assigned only at certain times, and not just when needed for the work. Even when the limited equipment is available, labor shortage may prevent its being used to full advantage.

Remedies suggested for this condition are noted by the engineers of several railways. One road installs temporary sidetracks with derricks near the work, so that material can be unloaded and piled whenever equipment is available. When a train is assigned, it is urged that care be taken to keep it busy and cut the idle time to a minimum. Other means of distributing material are found in some cases. These may include the use of motor cars and trailers, or utilization for company service of any empty cars in transit. Locomotives of insufficient power for regular traffic may be obtained, and cars of material for distribution may be handled to some extent in local freight trains. Gondola cars being forbidden for company service, some roads have been hauling sand, gravel and stone in large dump cars, the height of the sides being increased and the bodies blocked up on the frames to prevent accidental dumping while on the road. As a rule these cars may be hauled only in local trains. Work-train schedules should be planned carefully in advance, it is pointed out, so that the trains can work without delays due to poor distribution of men and materials.

Elimination of Unnecessary Work

Much work ordinarily done to improve the appearance of the line can be eliminated, it is pointed out, without affecting the condition of the property. This is becoming general practice, and in fact it is effected automatically in some cases, since the reduced track forces are insufficient for anything beyond what is really necessary. Such work is mentioned as hand dressing of ballast slopes, trimming of sod lines, mowing of right-of-way, clearing of station grounds, parking and gardening at stations, and painting of signs or structures. One road has given up its periodical track inspections by officials.

Trimming of ballast slopes is done on some roads by a device attached to the wing of a spreader car, and weeding along track can be dispensed with by the occasional use of a weed-burning or weed-killing car. The right-of-way may be burned over or left uncut, and one road reports that it now limits this clearing to the growth along the shoulder of the roadbed. Some roads report that they can make no saving in this way, as they have never practised "sandpapering" or decorative work. Others have made a special feature of keeping the property in good appearance. But the general opinion is that for some time to come the main points of attention will be the line and surface of track, the rail joints and fastenings, and the switches or turnouts.

Disregard for appearances, however, must not, it is held, be carried to such an extent as to result in dirty, untidy and unsightly roadway, station grounds and buildings. A condition of this kind would be reflected in a lowering of the morale of the force. This is a matter to be determined by good judgment and common sense.

Navy Engineer Advocates Asphalt Blocks for Warehouse Floors

FOR the new general storehouse at the Brooklyn navy yard an extensive investigation was made into the question of floor surfaces to meet the heavy traffic conditions surrounding the use of such floors. As a result of this investigation, the Navy Department decided to adopt compressed asphalt blocks. An explanation of the reasons underlying this choice is given in Bulletin No. 29, Public Works of the Navy, by H. S. Rinker, expert aide, bureau of yards and docks.

Mr. Rinker says that wood, concrete, and bitumastic floors all have serious objections for warehouse service; in seeking for some other type which would avoid the difficulties due to the kinds named, the asphalt block was investigated in its numerous uses through the past 25 years. It was found to have stood up with remarkably little loss from wear, although the older blocks in service were apparently not equal to those now made.

The floors laid at the Brooklyn yard involve about 8,000 sq.yd. of surface over an interior floor 360 x 180 ft. in plan and a shipping platform 12 ft. wide entirely around the building. The blocks are laid continuously through the first floor of the building and across the shipping platform, no breaks being made at the doorways, although the platform is slightly graded away from the building for drainage. The floor is composed of a 6-in. slab of unreinforced concrete laid directly on the tamped and puddled fill. On this a bed of 1:3 mortar, ½-in. thick, is laid and struck off with a screed. The wearing surface of compressed asphalt blocks is laid directly on the mortar bed without jointing material of any kind and leveled by light rollers, after which sand is spread over the blocks. This is removed before the floor is put in active operation.

The blocks under traffic have the peculiar property of welding or joining so as to present a close, smooth, sanitary surface capable of carrying almost any traffic, yet easily raised for repairs when necessary. The same blocks can be relaid when the concrete bed has been restored to grade. They are 5 x 12 in. in surface dimension and 2 in. thick. Mr. Rinker states that the advantages which the Government designers expect to attain in this floor are several, and all of the first importance. He says: "In the first place, the resultant floor is proof against fire, water, acid, alkali and oil. It is dense and at the same time elastic. It is remarkably easy to repair. It requires no jointing material as do brick or wood block, and does not not need to be creosoted. It does not require as much surfacing material as either wood block or vitrified brick and will not wear and dust, an important point in a storehouse where heavy and continuous traffic occurs. It permits of ready repair, requiring no special tools or trained labor. It is cheaper than brick or wood block, and where it passes from indoors to out requires no treatment for weather exposure."

Wooden Trestle Replaced Piecemeal by Concrete Structure

Annual Reconstruction Cost Kept Within Income -- Short Bents Put In Where Old Wooden Ones Have Decayed

THE South San Joaquin Irrigation District, located about 100 miles southeast of San Francisco, gets its water from the Stanislaus River through a main canal for the most part in open ditch or tunnel. One long trestle was required, however, across what is known as Hilts Sag. When the irrigation system was built about five years ago it was deemed most economical, figuring on a 15-year life for timber, to build this structure of wood. Batter posts were made of 6 x 8-in. timbers and bents were spaced on 12-ft. centers, these being figured as the most economical dimensions. The flume has a total length of 2000 ft. and a maximum height of about 70 ft. The capacity is about 1000 sec.-ft. and the cross-section of the flume proper is 9½ x 14½ ft.

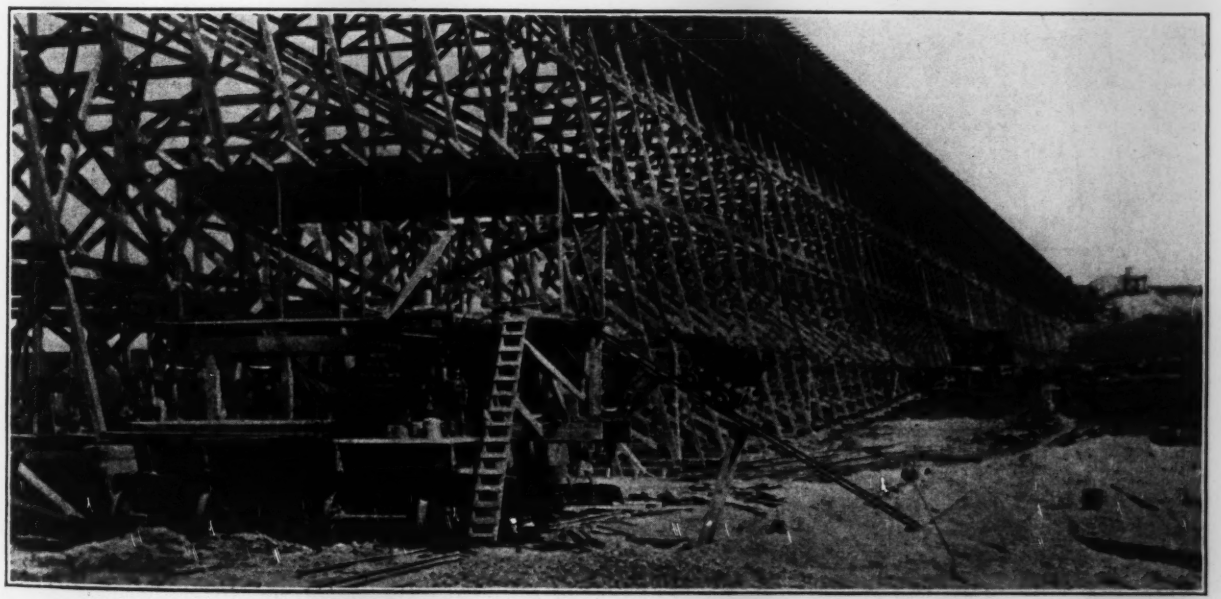
Because it is practically impossible to keep the flume seams tight there is always more or less leakage when water is in the flume and this keeps the trestle bents wet much of the time. Weather action on the long timbers which were subject to heavy load caused warping, splitting at knots and ends, and some crushing at joints. Thus after about five years of service the defects appearing in the batter posts were such that the safety of the tall trestle began to be questioned.

There were no funds available for reconstruction and the difficulty of raising money postponed action on the matter. The chief engineer for the district, however, devised a plan for rebuilding the flume without a bond issue or special assessment. This plan, now well under way, involves the expenditure of about $25,000 per year, which is approximately the annual income of the district available for this work. The work is somewhat more costly, perhaps because of being done while the old trestle is still in place, but by using 12-ft. bents the concrete structure is being erected section by section between the wood bents and in such a way that there is no interruption in the delivery of water supply.

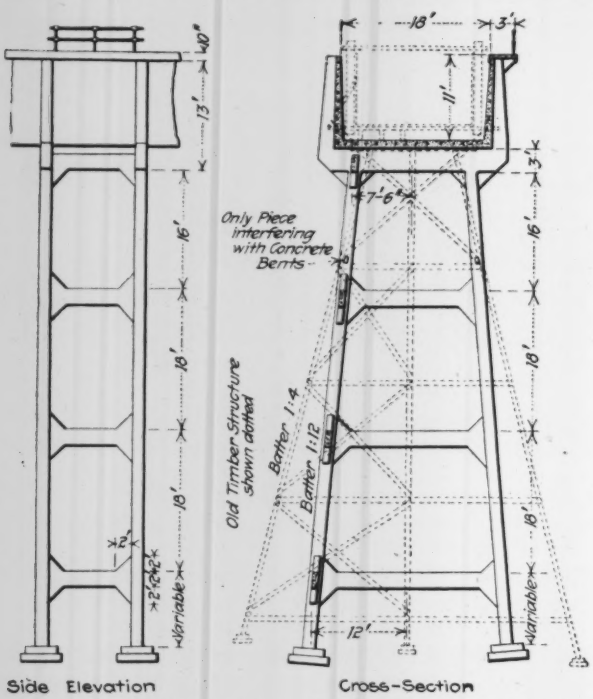
BENTS IN PAIRS BEING FITTED IN BETWEEN TIMBERS

The concrete bents are built in pairs, as the illustrations show, and thus each pair can be erected as an independent structure. By beginning on the parts of the trestle where the indications of weakness are most serious, the concrete work is completed first where it is needed most. As soon as the concrete has properly set the new bents are put in service, relieving the wooden bents. Thus the work is being done in independent sections, first at one point and then at another. At present only the bents are being replaced, the flume itself being left as it is and blocked up on the new bents. The drawings show the details of the proposed concrete flume.

In order to facilitate movement from bent to bent as well as from one point to another, the mixing plant and tower for hoisting the concrete, including the hoist with its engine, are mounted on a car which moves

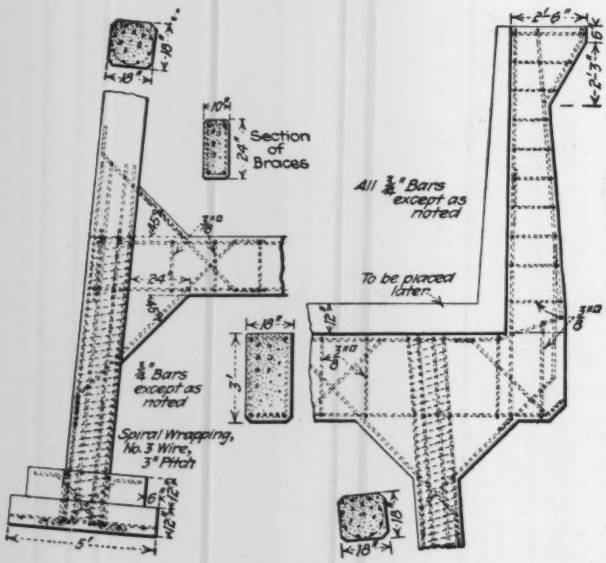


MIXER PLANT MOVES ALONG AS WORK ON THE TRESTLE PROGRESSES



DETAILS OF THE REINFORCED-CONCRETE BENTS TO REPLACE OLD WOOD TRESTLE

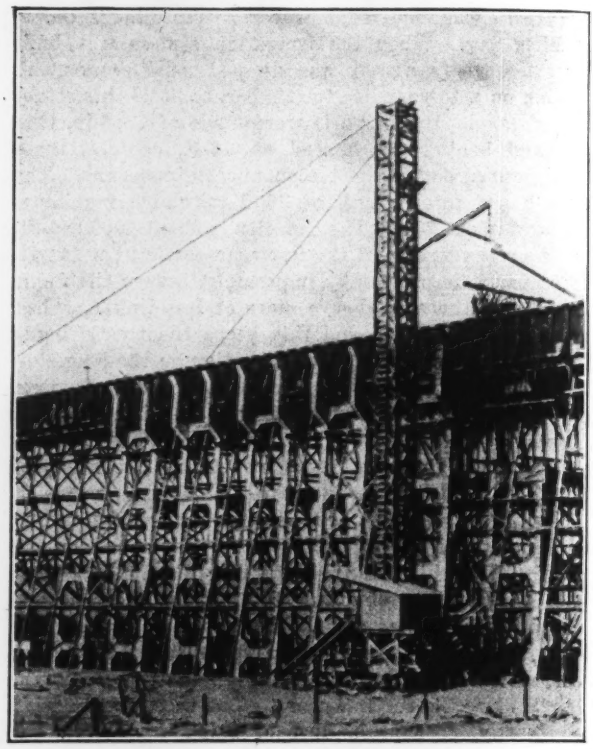
alongside the flume on four rails. Four freight car trucks were used in making this car. Storage space is provided on the car for cement for a day's run. The car is moved by a powerful hand winch mounted on the car itself, and operating on a ½-in. cable anchored at each end of the track. The engine which drives the mixer also hauls in aggregate from the supply piles along the tracks by means of a modified side loader. When in service the tower, which is 110 ft. high, is guyed in four directions to deadmen. When moving, it is stayed by the guys to the car deck.



HOW THE NEW CONCRETE BENTS ARE REINFORCED

The concrete bents were designed for minimum interference with the wooden structure during erection. In fact, only one piece, a longitudinal brace near the top, has to be removed to make room for the concrete forms. The top of the old flume, on the other hand, serves as a handy working platform in connection with the placing of the topmost forms. It has also been found convenient to operate a traveler along the top of the flume.

Under this plan of piece by piece construction the progress of the work is necessarily slow, but the urgent and immediate needs of the wooden flume are being provided for and it is believed worth the small additional cost to avoid the raising of special funds. The total cost of the trestle bents on the present basis will be about $150,000 and the work is expected to be finished, except for the flume box, by the end of 1920.



NEW FLUME CONCRETE BUTTRESSES IN PLACE

The reconstruction plan was worked out and construction started under the direction of A. Griffin, chief engineer for the district, who was recently succeeded by R. W. Olmsted. Mr. Olmsted was formerly resident engineer in charge of construction at the flume and was succeeded by C. W. Wood.

An Effective "No-Smoking" Notice

In a wooden shipyard of the Northwest, where 3000 men are working on rush schedule, it is important to impress on them the danger of breaking the rule which absolutely prohibits smoking. This is accomplished by a sign placed just inside the workmen's entrance, which reads, in large flaming letters: FIRE in this plant may put every man out of work. Help the management protect your job. NO SMOKING!

Equal Payments To Liquidate a Debt with Interest

Formula Is Derived To Take Into Account Diminution of Deductions from Principal as Installments Are Met

By R. B. Shepard, Jr.

Office Engineer, Valuation Department, Atlantic Coast Line R.R. Wilmington, N. C.

FOLLOWING is the derivation of a formula for determining the amounts of several equal payments to be made at constant intervals to liquidate a debt of a certain sum, with interest at a given rate. By the method of average interest ordinarily used the debt is somewhat overpaid. The method here outlined is also applicable to bond issues, concerning which there have been of late, such lively discussions in *Engineering News-Record*. It probably affords the most economical method of all by which loans can be retired.

Let P = total principal; p_1, p_2, p_3 .... p_n, portions of principal to be paid at first, second, third .... and nth payments; n, total number of payments; r, interest rate for the fixed equal periods between payments, as $\frac{1}{12} \times 0.06 = 0.005$ for a 30-day period at 6% per annum; m, modulus of common system of logarithms, = 0.434294; a, amount of each of the several equal payments, and A, total amount, including interest, to be paid. Then

$$P = p_1 + p_2 + p_3 + \dots p_n$$

and

$$A = p_1 + p_1r + p_2 + 2p_2r + p_3 + 3p_3r + \dots p_n + np_nr = p_1(1 + r) + p_2(1 + 2r) + p_3(1 + 3r) + \dots p_n(1 + nr)$$

Each of the terms $p_1(1 + r)$, $p_2(1 + 2r)$, $p_3(1 + 3r)$ .... $p_n(1 + nr)$ represents the equal periodical payments, hence

$$p_1(1 + r) = p_2(1 + 2r) = p_3(1 + 3r) = \dots p_n(1 + nr)$$

Therefore

$$p_2 = p_1\frac{1 + r}{1 + 2r};\ p_3 = p_1\frac{1 + r}{1 + 3r};\ p_n = p_1\frac{1 + r}{1 + nr} \quad (1)$$

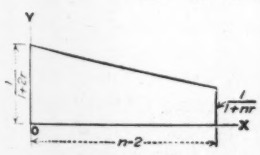
and

$$P = p_1 + p_1\frac{1 + r}{1 + 2r} + p_1\frac{1 + r}{1 + 3r} + \dots p_1\frac{1 + r}{1 + nr}$$

or

$$P = p_1\left[1 + (1 + r)\left(\frac{1}{1 + 2r} + \frac{1}{1 + 3r} + \dots \frac{1}{1 + nr}\right)\right] \quad (a)$$

The terms $\frac{1}{1 + 2r}$, $\frac{1}{1 + 3r}$, ... $\frac{1}{1 + nr}$ can be regarded as ordinates of a curve cutting the Y axis at $1/(1 + 2r)$, and the sum of the terms can be found by calculating the area between the X and Y axes, the curve and the ordinate $1/(1 + nr)$, and adding thereto half the sum of $1/(1 + 2r)$ and $1/(1 + nr)$. The equation of the curve is



$$y = \frac{1}{1 + 2r + rx} = \frac{1}{c + rx}$$

where $1 + 2r = c$. The area is

$$\int_o^{n-2}\frac{dx}{c + rx} = \frac{1}{mr}\int^{n-2}\frac{d(c + rx)}{c + rx}\,m = \frac{1}{mr}\Big[\log(c + rx)\Big]_o^{n-2} = \frac{\log[c + r(n - 2)] - \log c}{mr}$$

and

$$\frac{1}{2}\left(\frac{1}{1 + 2r} + \frac{1}{1 + 3r} + \dots \frac{1}{1 + nr}\right) = \frac{\log[c + r(n - 2)] - \log c}{mr} + \frac{1}{2}\left(\frac{1}{1 + 2r} + \frac{1}{1 + nr}\right)$$

Substituting in equation (a) above,

$$P = p_1\left\{1 + (1 + r)\left[\frac{\log[c + r(n - 2)] - \log c}{mr} + \frac{1}{2}\left(\frac{1}{c} + \frac{1}{1 + nr}\right)\right]\right\}$$

$$p_1 = P \div \left\{1 + (1 + r)\left[\frac{\log[c + r(n - 2)] - \log c}{mr} + \frac{1}{2}\left(\frac{1}{c} + \frac{1}{1 + nr}\right)\right]\right\} \quad (2)$$

$$a = p_1(1 + r) \quad (3)$$

and

$$A = na \quad (4)$$

To determine the values of principal and interest in any particular payment, let p_x = principal and i_x interest at xth payment. Then from equation (1)

$$p_x = p_1\frac{1 + r}{1 + rx} = \frac{a}{1 + rx} \quad (5)$$

and

$$i_x = rxp_x;\ \text{also } i_x = a - p_x \quad (6)$$

Application of Formula

As a particular problem, let P = \$18,000; n = 29, the first payment becoming due 30 days after the giving of the note; $r = \frac{1}{12} \times 0.06 = 0.005$; m = 0.434294. Substituting in equation (2),

$1/(1 + nr) = 1/(1 + 29 \times 0.005)$	= 0.8734	
$1/c = 1/1.01$	= 0.9901	
	2) 1.8635	
	0.93175 =	0.93175
$\log[c + r(n - 2)] = \log[1.01 + 0.005(29 - 2)] = \log 1.145$	= 0.05881	
$\log c = \log 1.01$	= 0.00432	
	0.05449	

$mr = 0.434294 \times 0.005 = 0.00217147$

$0.05449 \div 0.00217147 =$	25.09360
	26.02535
Multiplied by $1 + r$	1.005
	26.15547675
Plus 1	1
	27.15547675

Hence p_1 = \$18,000 ÷ 27.15547675 = \$662.849 = first principal payment.

From equation (3), $a = p_1(1 + r)$ = \$662.849 × 1.005 = \$666.16 = amount of each of the 29 payments. From equation (4), $A = na$ = 29 × 666.16 = \$19,318.73. Of this \$18,000 represents principal and \$1318.73 interest.

The values of principal and interest in any payment, for example, the 29th or last, are, from equation (5),

$$p_{29} = \frac{a}{1 + 29 \times 0.005} = \frac{\$666.16}{1.145} = \$581.80$$

and, from equation (6),

$i_{29} = 0.005 \times 29 \times \$581.80 = 0.145 \times \$581.80 = \$84.36$

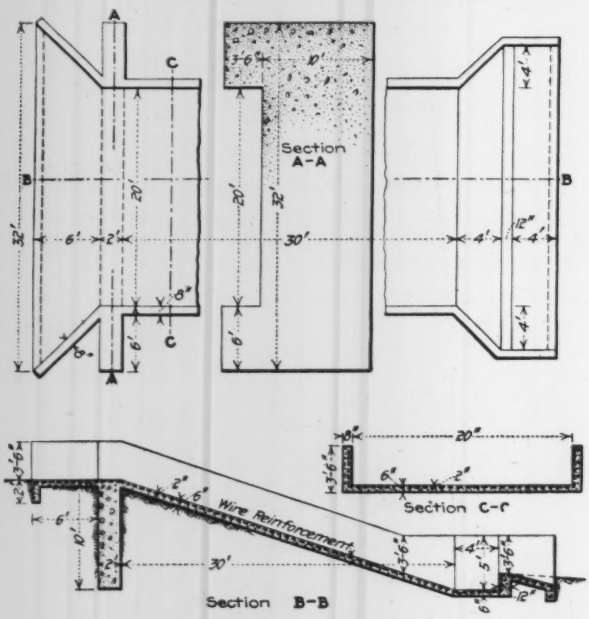
$\$581.80 + \$84.36 = \$666.16$

Note the difference between the interest actually accruing—that is, $1318.73—and the amount paid under the method of calculation by average, or $(29 + 1) \div 2 = 15$, and $15 \times 0.005 \times \$18{,}000 = \$1350$. This discrepancy arises from failure of the average method to give proper consideration to the diminution of the principal payments as the installments are met.

Concrete Drop Stops Highway Washouts in California County

WASHOUTS on a highway in San Bernardino County, California, have been prevented by the construction of the concrete drop or inclined flume shown in the accompanying view. This was built in 1917 at a place where the road had been almost destroyed, the washout being about 150 ft. wide and 15 to 18 ft. deep, as described by H. L. Way, deputy county surveyor.

Storm water had been carried in a fair-sized channel until it cut into a soil which was easily eroded and then the washout soon reached the dimensions noted. At the change of soil there was a fall of about 10 ft. It



STORM WATER IS CARRIED IN A CONCRETE FLUME TO PREVENT WASHOUTS

was desired to install some type of construction which would prevent any further cutting and washing at this place.

For this purpose several types of drop were considered, including steel sheet piling and a rock-filled pile bulkhead. The concrete structure adopted cost only about $500, which was less than estimated for any of the other plans. The lower end forms a basin to check the force of the water. The deep core wall was built by pouring concrete into a trench, no forms being used. This drop has withstood some heavy storms and fulfills its purpose successfully.

More Concrete Ships Are Being Built in England

Six Vessels of 1150 Tons Dead Weight Are Under Construction — If They Are Successful, Others Will Follow

CONCRETE ship construction is being started in England in an experimental way. At Barrow-in-Furness there are now on the ways six self-propelled sea-going steamships of a dead weight of 1150 tons, this size having been determined upon as being large enough to satisfy conditions of seaworthiness in an ocean-going vessel, at the same time not being so large as to endanger the success of the undertaking.

The design of these ships was made by reproducing the frame of a steel ship of the same dead-weight carrying capacity. Such a ship has a length between perpendicular of 205 ft., breadth of 32 ft. and draft of 15½ ft. Layout drawings were prepared and the structural frame arranged in accordance with Lloyd's rules for steel ships, and on the basis of such a steel frame a list was made up of the section moduli of the various sections. The engineers then prepared reinforced-concrete sections on a principle of equivalent strength, reproducing in the heavier material the strength of the steel. After such a design was completed calculations were made as far as possible for the stresses to which the vessel would be subjected longitudinally and transversely, under all reasonable conditions of construction and service.

It was found that in the reinforced-concrete hull the center of gravity was much lower than for steel hull, and that the metacentric height was greater than was desirable. To minimize this the original beam of 34 ft. was reduced to 32 ft., and to obtain the same hold capacity the depth was increased from an original 17½ ft. to 19½ ft.

The weight of steel in the concrete ship figured about 42½% of that in a steel ship of the same dead weight capacity, and the displacement of the latter would be 1800 tons against 2350 tons for the concrete vessel. This proportion of steel in the concrete ship to that of a steel ship is somewhat higher than some theorists have advanced, but the designers of the English ship felt that in the first vessel they should err, if at all, on the safe side, although they hope in service to discover where they can cut down the reinforcing steel.

When comparing the cost of the reinforced-concrete ship with that of steel the English investigators have made the following estimates: The total cost for a 375-ft. steamship in steel amounts to about 53% for the bare hull, 26% for machinery, and 21% for the remainder. While the concrete ship hull costs somewhat less than the steel hull, that saving is somewhat reduced by the extra weight of the concrete. However, the English engineers figured that the concrete ship would cost about 20% less than a similar steel ship at the present time. On account of the reduction in carrying capacity and the extra cost of operation of the heavier ship, they figure that in ordinary times the operation and carrying charges would make the steel ship the cheaper in the long run, although the original cost might be greater.

Revolutionary Results Obtained by Proportioning Water in Concrete Tests

Ratio of Water to Cement Found to Have More Important Effect on Strength Than Quantity of Cement or Grading of Aggregates

By Duff A. Abrams

Professor in Charge of Structural Materials Research Laboratory, Lewis Institute, Chicago.

CONCRETE, it is commonly stated, is composed of a mixture of cement, sand and pebbles or crushed stone. This conception of concrete overlooks one essential element of the mixture—water. An exact statement of the ingredients of concrete would be: Cement, aggregate and water. The last-named material has not yet received proper consideration in tests of concrete or in specifications for concrete work.

Early users of concrete centered their entire attention on the quality of the cement, and practically disregarded the characteristics of the other ingredients. During the past dozen years some attention has been given to the importance of the aggregate, but it is only recently that we have learned that the water also requires consideration.

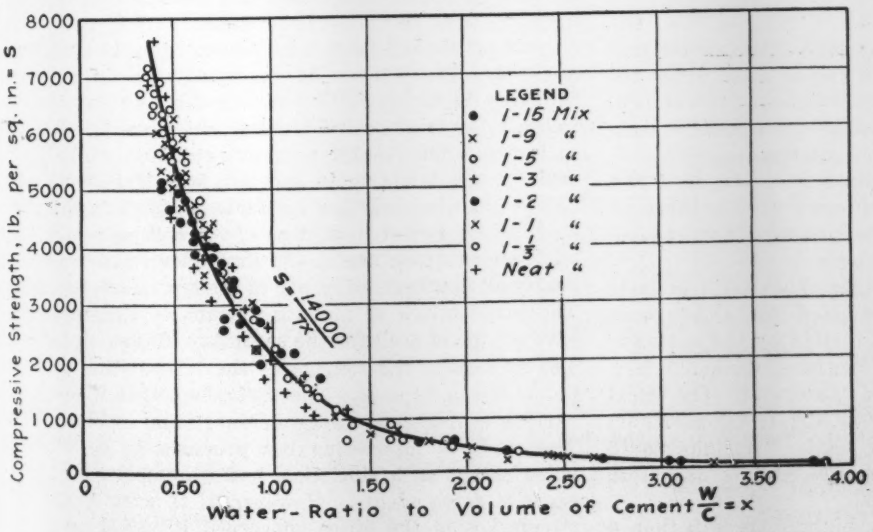
A great deal has been said and written recently concerning the effect of water on the strength and other properties of concrete, but the full significance of this ingredient has not heretofore been pointed out. A discussion which appeared in the April, 1917, issue of the *Concrete Highway Magazine* gave a brief review of results of some of the experimental work carried out along this line at the Structural Materials Research Laboratory, Lewis Institute, Chicago. The relation between the water content and the compressive strength of the concrete for a wide range of consistencies was there pointed out and emphasis was placed on the injurious effect of too much water. Tests made in studies of the effect of size and grading of aggregates have shown that the only reason concrete of higher strength and durability can be produced from well-graded aggregate as compared with a poorly-graded aggregate is that the former can be mixed with less water. If this is not done no advantage is gained from using a coarse, well-graded aggregate. The following discussion shows that a similar conclusion can now be stated with reference to a rich concrete mix as compared with a lean one.

While the injurious effects of too much water in concrete is apparent, tests made in this laboratory show that the truly fundamental role played by water in concrete mixtures has been entirely overlooked in previous discussions of the subject. The relation referred to above is brought out by a series of compression tests of about 1600 6 x 12-in. concrete cylinders made up as follows:

Mix Cement-Aggregate	Range of Sizes of Aggregates	Consistency
1:15		
1:9	0-14-mesh sieve	
1:5	0- 4-mesh sieve	Different consistencies for each mix and aggregate
1:3	0-¼-in.	
1:2	0-½-in.	
1:1	0-2-in.	
1:½		
Neat		

The mixes used covered a wide range, as did also the grading of aggregate and consistency. The aggregates consisted of two sizes of sand and mixtures of sand and pebbles graded to the sizes shown. The mix is expressed in terms of volumes of dry cement and aggregate, regardless of grading; i.e., a 1:5 mix is made up of 1 cu.ft. cement (1 sack) and 5 cu.ft. of aggregate as used, whether a sand or a coarse concrete mixture.

This series gives valuable information on the effect of changing the quantity of cement, the size of the aggregate and the quantity of water. The effect of many different combinations of these variables can be studied. One set of relations gives the effect of amount of cement using aggregates of different size and grading; another set of relations gives the effect of different quantities of water, varying both mix and size of aggregate. In all respects the tests bear out the indications of earlier and later series, and reveal the true relation between the strength and the proportions of the constituent materials in concrete. The figure shows the relation between the compressive strength and the water content for the 28-day tests. The water content



LEAN AND RICH MIXTURES SHOW STRIKING SIMILARITY IN STRENGTH VARIATION FOR DIFFERING WATER CONTENTS

of the concrete has been expressed as a ratio of the volume of cement, considering that the cement weighs 94 lb. per cu.ft. Distinguishing marks are used for each mix, but no distinction is made between aggregates of different size or different consistencies.

When the compressive strength is platted against the water in this way, a smooth curve is obtained, due to the overlapping of the points for different mixes. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix. This gives us an entirely new conception of the function of the constituent materials entering into a concrete mix and is the most basic principle which has been discovered in our studies of concrete.

The equation of the curve is of the form,

$$S = A/B^x \qquad (1)$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch, A and B are constants whose values depend on the quality of the cement used, the age of the concrete, and curing conditions.

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. It is seen that for given concrete materials the strength depends on one factor only—the ratio of water to cement. Equations which have been proposed for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate; but they have uniformly omitted the only item which is of any importance, the water.

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate not too coarse for a given quantity of cement; in other words, so long as we have a workable mix.

For the conditions of these tests, equation (1) becomes,

$$S = 14{,}000/7^x \qquad (2)$$

Other tests made in this laboratory have shown that the character of the aggregate makes little difference if it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates.

In certain instances a 1:9 mix is as strong as a 1:2 mix, depending only on the water content. The strength of the concrete responds to changes in water, regardless of the reason for these changes.

It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix. So in the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

The reason a rich mix gives higher strength than a lean one is that a workable concrete can be produced by a quantity of water which gives a lower ratio of water to cement. If an excess of water is used we are simply wasting cement. Rich mixes and coarse, well graded aggregates are necessary as ever, but we now know just how these factors affect the strength of the concrete.

Practical use may be made of the curve in estimating the relative strength of concretes in which the water content is different for any reason. For example, a concrete mixed with 7.5 gallons of water (1 cu.ft.) to one sack of cement (allowance being made for absorption of aggregate) gave a strength in this series of 2100 lb. per sq.in. ($x = 1.00$). For $x = 0.80$ (6 gal. of water per sack of cement) we have 3000 lb. per sq.in.; for $x = 0.75$ (5.6 gal.) 3300 lb. per sq.in. Concrete in a 1:4 mix (same as usual, 1:2:3 mix with a coarse sand) should be mixed with 5½ to 6 gal. of water per sack of cement.

The importance of any method of mixing, handling, placing and finishing concrete which will enable the work to be done with a minimum of water is at once apparent. It now seems that practically all faulty concrete work can be traced to the use of too much water.

These studies lead to many important conclusions with reference to such topics as tests of cement, tests of concrete containing admixtures, etc. Tests of cement from this viewpoint have been under way several weeks.

Conditions in Thirty-six Cities Compared

A study of the relative standing of 36 American cities with reference to 18 municipal conditions was made recently by the students of Reed College, Portland, Ore., under the direction of W. F. Ogburn, professor of sociology ("A Statistical Study of American Cities," No. 27, Reed College Record, December, 1917). Ostensibly the study was initiated to enable prospective residents or manufacturers to obtain a correct statistical comparison of the relative merits of the various cities. Tabulated results are given on wage rates, cost of living, death rates, infant mortality rates, population married, church membership, child labor, parks, pavements, fire loss, public property, circulation of library books, school attendance, school property, teachers' salaries, number of pupils to a teacher, illiteracy and foreign-born unable to speak English. Under each condition the cities were ranked from 1 to 36, according to excellence attained. These place figures were used in a grand summary in which the lowest numbers are designed to indicate the most desirable city. Seattle and Salt Lake each were rated 215, the best rank obtained, while Birmingham, the last city in the list, was loaded up with 523 points. In analyzing the facts set forth in the summary W. T. Foster, president of the college, states that all Western cities are in the first quarter in rank and nearly all Southern cities are in the last quarter in rank. The presentation is made by means of diagrams and text, a page of each for the several conditions presented. The text gives the sources of the information and explains the units used. The basic data were taken from various sources and range in date from 1906 to 1915. The study is interesting but promises to be of little value except as a statistical and graphical sociological exercise for students. However, if it were given free circulation in the cities concerned it would swell the pride of some and perhaps would stir up enough shame in others to lead them to undertake needed local reforms.

Typical Rules for Operation of Small Sewage-Works

Should Be Placed in a Tool House on Premises Where the Inevitable "New" Man May Easily Locate Them

CLEAR-CUT instructions for sewage-works operation should be left on the job with the operator, not filed in the city clerk's office. This is particularly true of small town plants where the operators change frequently and usually have no technical training. In 39 plants in Iowa visited in the summer of 1917 by Prof. J. H. Dunlap for the State Board of Health 12 had no regular care, 8 were in charge of engineers, 6 of the street commissioners, 5 of the city marshal, 4 of the water-works superintendent, 1 of the marshal and street commissioner, 1 of the chairman of the sewer committee, 1 of the mayor and 1 of the city clerk. (Other details of the results of the inspection appeared in *Engineering News-Record*, Apr. 18, p. 773.)

Professor Dunlap found no instructions at any of these plants. In a paper presented recently to the Iowa Engineering Society he urged engineers to include a tool house in their designs and to leave in it directions for operating procedure. The following rules, proposed for the State Hospital sewage-works at Woodward, were given as an example and good practice that should be followed:

DAILY

1. Visit the plant.
2. Give every part of the plant careful inspection.
3. Record the amount of sewage flow.
4. Fill out the report blank for the day.

WEEKLY

1. Take samples of raw sewage and of tank effluent in the Imhoff conical glasses, and find the per cent. removal of solids after two hours settling. It should average 95%.
2. Break up the scum in the gas vents with the hose.
3. Measure and record the depth of sludge in the sludge chamber.
4. Clean the inflow channels and the inlet and outlet weirs.
5. Skim the sedimentation chamber.
6. Squeegee the side walls, aprons and slot. (This may have to be done more or less frequently.)
7. Take a sample of the filter effluent for the methylene blue test for relative stability. When kept at a temperature of 68° F. the blue color should be retained for at least 10 days.
8. Operate all valves.
9. Turn water through the sludge grids for one minute.
10. Fill out report blank to date.

NEVER

1. Never fill the tank with sewage when empty. Use water.
2. Never unnecessarily agitate the contents of the sedimentation chamber.
3. Never bypass sewage either at the inlet or from the siphon chamber without recording the reason, date and duration, and notifying the State Board of Health within 24 hours.
4. Never run out large amounts of sludge at a time; better small amounts every two to six weeks.
5. Never withdraw all the ripened sludge. Some should be left to seed the tank.
6. Never fill the sludge bed to a depth of more than 18 inches.
7. Never allow the sludge in the sludge chamber to rise closer to the slot than 2 feet.
8. Never stir the surface of the sand filters to a depth greater than ½-inch.
9. Never allow the filter beds to stand flooded.
10. Never bypass sewage directly to the underdrains by digging holes through the sand.
11. Never allow weeds and grass to clog the surface of the filters.
12. Never add new sand which has not been approved by the State Board of Health.

ALWAYS

1. Always recollect that the business of this plant is to transform the organic matter in the sewage so that the final filter effluent will be clear and nonputrescible.
2. Always keep in mind that only about one-third of the total organic matter settles out in the Imhoff tank.
3. Always remember that the remaining two-thirds must be oxidized by bacterial action in the sludge beds into harmless mineral compounds.
4. Always backfill the sludge pipe with water, and flush out the pipe running to the sludge bed after withdrawing sludge.
5. Always clean the surface of the sludge bed before applying a new dose, and add more top sand if necessary.
6. Always make sure that there is enough room in the sludge chamber for the winter sludge.
7. Always note the distribution of sewage over the filters, and if uneven, correct it by releveling the beds or rebaffling the distributors.
8. Always keep the filter surface open by raking or harrowing to a depth not greater than ½ in. When this fails to prevent ponding, remove the upper ¼ in. of sand and surface mat. Not more than 1 in. of sand should be removed in one year.
9. Always give the beds a thorough overhauling in the late fall just before freezing weather. Pile up the dirty sand in small piles 6 to 8 in. high and 3 to 6 ft. apart. These piles will help support the ice.
10. Always watch for warm days in winter, when the surface of the filters may be put into good condition.

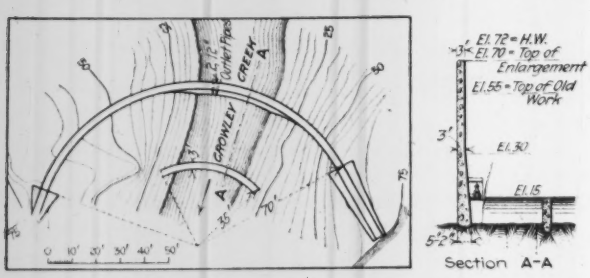
B. & O. To Use Pennsylvania Terminal in New York City

One of the first radical readjustments of railroad facilities made by the Director General of Railroads is the order which took effect Apr. 28, that the Baltimore & Ohio R.R. shall use the big Pennsylvania terminal in New York City, instead of running its New York trains into its present terminus across the Hudson River in Jersey City. The order routes the Baltimore & Ohio trains on their present tracks to Bound Brook, N. J., thence over the tracks of the Lehigh Valley to the Pennsylvania tracks at Newark Junction.

Concrete Arch Dam 70 ft. High Has 62-In. Base

Withstood Overtopping 2 Ft. Deep at Original Height of 55 Ft. and Has Been Overtopped Since

ONE of the thinnest if not the thinnest arched concrete dams for its height in the world has seen several years' service on Crowley Creek, Malheur County, Oregon. The dam is all the more notable because it has no reinforcement. It is 62 in. thick at the base, 36 in. at a height of 30 ft. and continues that thickness for its upper 40 ft. As designed in January, 1907, it was to have a height of 65 ft., and to be overtopped to a depth



THE LOW DAM FORMS A WATER CUSHION TO PROTECT THE TALL, SLENDER ARCHED DAM

of 5 ft. It was built that year to a height of 55 ft. In December, 1911, an addition of 15 ft. to the height of structure was designed. This was built in 1914.

The dam has a radius of 70 ft., an arc of 130° and a crest length of 158 ft. It is founded on bedrock, which was found exposed at the bed of the stream and nearly all the way up the walls of the cañon.

The dam being subject to overflow, a concentric pool or water cushion 35 ft. wide is provided just below it by means of an arched dam 3 ft. thick, 15 ft. high, with a radius of 35 ft.

In adding 15 ft. to the height of the dam the first step taken was to set steel anchors in holes drilled in the top of the original dam. Forms were then built up on the old structure and concrete was poured. To reach rock abutments it was necessary to build the ends of the addition as tangents. These were carried up 3 ft. above the curved portion of the dam, in order to so confine the overflow that it will strike on sound rock. The wing walls are 30 in. wide on top, with batters of 1 in 4 on each side.

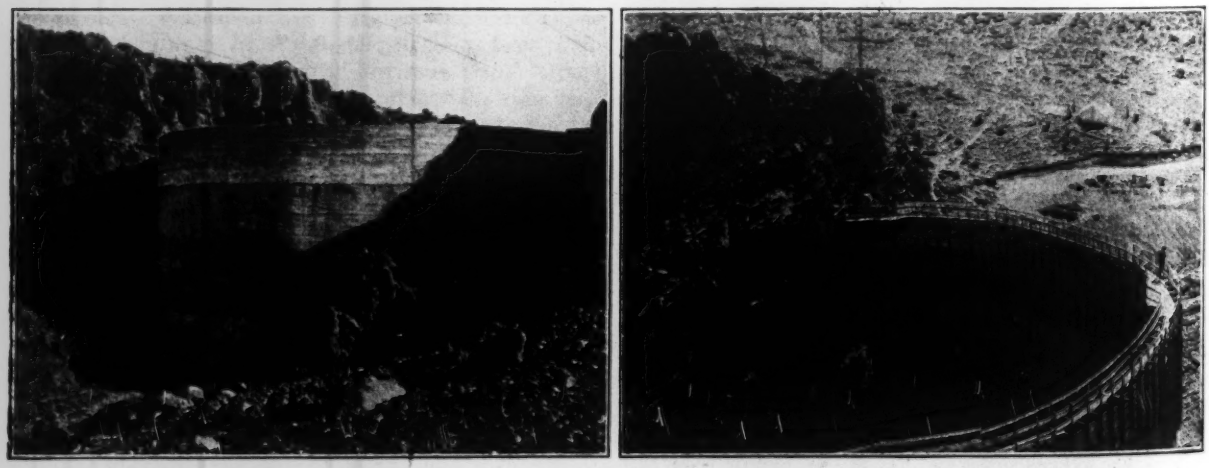
The original dam was overtopped several times to a depth of 2 ft. without damage to the structure. Once, when the water in the reservoir was frozen to a depth of about two feet a sudden rise in the water level caused the ice to break up and pass over the dam. Even under these conditions the only damage sustained was the demolition of the valve house at the downstream toe. Since the addition was made the dam has been overtopped, though probably not to quite as great a depth as previously, because of the increased length of spillway.

The plans and specifications for the original structure were drawn by A. J. Wiley, consulting hydraulic engineer, Boise, Idaho, who supplied the foregoing information. Construction of the first 55 ft. in height was carried out without engineering supervision, with a resultant flattening of the arch near the center. Plans for the 15-ft. increase in height were made by A. T. Ingalls, also of Boise. The structure is owned by the Malheur Live Stock & Land Company.

Large Growth in Clay-Producing Industry

The results of a canvass of the clay mining industries for 1917, which have just been announced by the United States Geological Survey, show that the total output of clay products has increased 47% in one year. Measured in the value of the product the increase is 61%. Information was sought concerning only the principal varieties of clay mined in the United States—kaolin, paper clay, ball clay and fire clay. The outstanding features of the investigation were the large increase in the quantity of products marketed and a still larger increase in its value. The production for 1917 is estimated at 4,301,000 tons valued at $9,285,000, a gain of 1,368,000 tons in quantity, or 47%, and of $3,533,000 in value, or 61% compared with 1916.

The gain in production was made principally by an increase in the production of fire clay, as might naturally be expected in view of the large increase in the output of coke, iron and steel.



ARCH DAM PROBABLY HOLDS RECORD. (1) AS ORIGINALLY BUILT. (2) FORMS IN PLACE FOR RAISING.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

The Control of Foaming in Imhoff Tanks

Sir—With reference to the symposium on foaming in Imhoff tanks which appeared in your issue of Apr. 4, p. 671, I should be glad to know if petroleum ether has been tried as a means of breaking the foam. It may be that the cost would be too great.

Foaming can be held in check by the use of a paddle rotating in a horizontal plane just beneath a hole cut in the cove of the tank. A four-bladed paddle with arms 2 ft. long, rotating about 8 in. below the cove, at a speed of 60 r.p.m. has been successfully used in coping with very violent foaming of other liquids. In a large plant this might be worth trying.

Vancouver, B. C. J. PORTER.

Sir—Observations to date seem to indicate that "foaming" in Imhoff tanks is usually associated with fresh sewage, though by no means invariably so; that, where it is not chronic, it frequently appears during the early stages of operation only, but sometimes manifests itself only after the tank has been in operation for many months, in which latter case such appearances commonly coincide with the beginning of hot weather; that foaming is not confined to acid sludges but may be associated with an alkaline sludge; that frequent withdrawals of sludge tend to retard it; that lime dosage is of uncertain value as a preventive; that foaming occurs only in conjunction with very vigorous gasification; that its occurrence is retarded by ample vents and favored by restricted vents tending to concentrate the gas bubbles where they escape at the surface of the liquid as, for instance, the chimney type of vent used with the radial-flow Imhoff tank; that a marked viscosity of the liquid is a necessary condition for foaming.

From the foregoing, and from personal observation of foaming tanks, the writer is inclined to draw the following conclusions:

The liquid in the lower compartment of a two-story septic tank remains practically unchanged, except for a slow displacement by the deposition of sludge accumulations through the slot. This, of course, supposes that sludge withdrawals are not frequent and systematic, since repeated withdrawals of sludge at short intervals will bring about frequent dilutions of the liquor in the lower chamber with fresh sewage. Kept in constant and intimate contact with highly unstable organic matter undergoing vigorous decomposition, the liquor tends to take large quantities of matter into solution and to become viscous. This viscosity, associated with the rapid escape of gas bubbles at the surface of the liquid in the vents, tends to bring about the phenomenon known as foaming.

Intense gasification is favored by the vigorous decomposition of sludge from fresh rather than from stale sewage; by the comparatively more extensive action incidental to large deposits of sludge, other things being equal; and by hot weather rather than cool.

As regards viscosity, it seems reasonable to assume that fresh sludges and large deposits would favor it. No doubt there are, however, certain constituents, varying with different sewages, the presence of which particularly favors viscosity. Possibly soap may be one of these, though I am inclined to think that the viscosity is generally attributable not so much to soap as to the presence of large quantities of other matters in solution.

The writer desires to suggest that engineers and chemists in charge of test plants or state health departments equipped with laboratories and having foaming tanks within their jurisdiction, might find it worth while to conduct tests to verify the foregoing deductions. The tests I have in mind are as follows: (1) Hydrometric tests of liquor from the lower compartment of various two-story tanks (foaming and non-foaming) and from various portions of the compartment. (2) Studies to determine the matters responsible for viscosity in various tanks, and the degree of viscosity associated with them. (3) Studies to determine the characteristics of sewages inclined toward foaming when treated in Imhoff tanks (if such identification is possible), in order that the probable behavior of a sewage may be established in advance of the design.

Should the foregoing theory of foaming be established by the tests, various means will at once suggest themselves for alleviating the difficulty, in the form of modified tank designs, etc.

New York City. WALDO S. COULTER, Consulting Engineer.

Unified Railroad Operation

Sir—The following plan for saving operating expenses on the Western railroads is submitted for the consideration of engineers. The idea was presented to the War Department in 1914 as a proposed method for handling military supplies in the event of invasion.

The basic idea is to combine two railroads to give the practical effect of one double-track railroad. For instance, we will use the case of the Chicago, Milwaukee & St. Paul and the Northern Pacific between St. Paul and Seattle as an example. Here are parallel railroads; now if the St. Paul carried all the through westbound freight and the Northern Pacific all the through eastbound freight it would double the capacity of these railroads without an appreciable increase in cost of operation.

Between Seattle and St. Paul the St. Paul is approximately 90 miles shorter than the Northern Pacific. This means that all freight of the Northern Pacific has to be hauled this additional distance with all additional expense.

It would require study to determine in the case of our transcontinental roads which should be designated as eastbound and which westbound roads. The decision would rest largely on the amount of adverse grades against the main direction of the traffic, and the length and curvature.

The greatest need for railway improvement on the Pacific Coast is the double-tracking of the Southern

Pacific between Portland and San Francisco. The same result could be achieved by the construction of another road between these points.

One great loss to the public is inadequate terminals. Every town with a population of more than 100,000 that has two or more lines of railroad could organize a terminal company. The local chambers of commerce should take charge of this.

In the matter of equipment, bad-order cars are a great source of loss. Bad-order cars are tinkered with, much time being lost here. Bad-order cars should be pooled at terminal points and all repairs rushed.

FRANK W. HARRIS,
Captain, Company B, 42nd Engineers.
Camp American University, Washington, D. C.

Ventilation of Highway Tunnels

Sir—The writer is interested in the proposed highway to be built in tunnel beneath the Hudson River, an account of which was published in *Engineering News-Record* of March 21.

On several occasions similar projects have been suggested in the city of Chicago, to pass under the river, under a park, or under some industrial establishment where it is impracticable to establish a street at the level. Objection has always been made that such a highway in a depressed tunnel would be poorly ventilated, would be hard to police, and in general would be objectionable to passengers. It is recognized that street cars may be operated satisfactorily through such a subway. But for ordinary vehicles, especially where gasoline motors are used for propulsion, the conditions would be objectionable and indeed unsafe unless such a subway was properly ventilated.

The writer would be interested to know of the successful operation of such subways for ordinary street use, particularly where the street in tunnel is depressed so that there is little opportunity for a draft of air to pass through from end to end. It would be of interest to know the extent and use of such subways.

The illustration showing the proposed method of construction of the tunnel under the Hudson River indicated that provision is made for ventilation. However, the many failures of installation of machinery for ventilation do not give complete confidence that any particular problem has been properly solved. The casual manner in which ventilation is provided by technical men who are experts in other lines is illustrated by the plans for the Court House in the city of Chicago, built a few years ago. These plans indicated diagrammatically ventilation ducts which were sufficient in size and number to perform their function. But when construction was undertaken it was found that it would be necessary to omit the structural steel if these ventilation ducts were installed as designed. As a necessary consequence the ventilation ducts were reduced to such sizes and numbers as were compatible with the safe construction of the building, and in consequence the air of the court rooms has not been fit for breathing.

The writer would be very much interested in a description of the proposed method of ventilation of this tunnel and particularly the computations that were used in determining the amount of air that would be needed to replace the air that had been vitiated by thousands of motors each day.

C. D. HILL,
Chicago. Engineer, Board of Local Improvement.

[The Public Service Corporation of New Jersey in its investigations of the feasibility of the proposed Hudson River tunnel, made in 1916, carried out extensive experiments to determine what ventilation would be required. A chamber was built representing a section of the tunnel, light automobiles were placed in it, and tests were made of the air in the chamber under various conditions. As a result of these tests, in connection with the experience in the use of the Blackwell and Rotherhithe vehicle tunnels under the Thames, the board of engineers concluded that with a proper ventilating plant it would be possible to operate the Hudson River tunnel without danger to those using it. The report to the Public Service Corporation of New Jersey on the proposed tunnel was made Feb. 20, 1917, and was reviewed in *Engineering News-Record* April 19, 1917.—Editor.]

Truly a Wonder-Working Instrument!

Sir—Writers of fiction have always treated the engineer and his profession with a careless disregard, and writers of pseudo-scientific subjects have long been thoroughly convinced that engineering is a lost art. Surely, from the writer of history the engineer might have expected a bit more of consideration. However, in a little history of the Susquehanna and Chenango Valleys written and published in 1840 we find the following choice morsel:

"Prior to the settlement either of Union or of the Chenango Valley, Colonel Hooper, the patentee of the tract bearing his name, was sent by Bingham, Cox and, it may be, others to survey the shores of this part of the Susquehanna. He traversed it up and down, in an indian canoe, managed by a faithful indian whom he employed. He would lie down in the canoe, with an indian blanket thrown over him, and take the courses and distances with a pocket compass, in this incumbent position. This precaution he took through fear of being shot by indians on the shore. After this survey, a purchase was made of the Susquehanna Valley from the Great Bend to Tioga Point."

Who has anything to say now about the building of the pyramids being a lost art? Here we have undoubted proof that the finer points of surveying itself have been lost by the unworthy descendants of the old-time engineers.

What a boon it would be to coast survey and to the deep waterways survey if someone could only discover this compass that the good old colonel used to "take the courses and distances"! The fact that he surveyed with a blanket over his head is not so much a matter of wonder, since many of us are thoroughly convinced from careful reading of various descriptions contained in the average deed that some such method must be very prevalent even at the present time—but, oh, for that compass!

Binghamton, N. Y.

W. E. WELLER,
City Engineer.

HINTS FOR THE CONTRACTOR

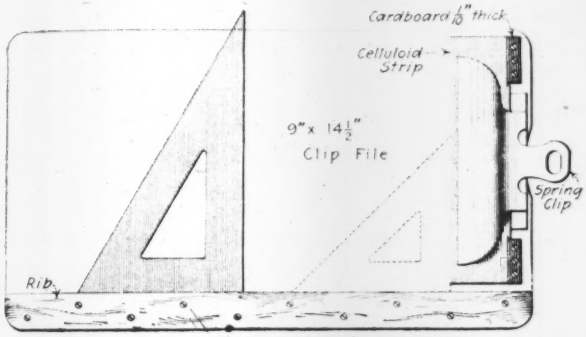
DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Make Clip File Into Handy Sketch Board

BY R. T. BROWN
Assistant Highway Engineer, State Highway Department, Columbia, S. C.

CLIP files are used on a good many construction jobs to hold paper for taking notes in the field, but one was recently made by the writer on which a triangle could be used, and which proved very handy for making sketches.

As shown in the drawing, the strip along the edge of the board is made of wood about ¼ in. thick. A piece of an old ruler or yardstick will do. This is planed to



CONVENIENT FOR MAKING SKETCHES OR PLANS OF LAYOUT ON THE JOB

a straight edge and fastened on with shoe nails or ordinary pins cut the proper length. The thin strip of celluloid at the top is raised about 1/10 in. from the board by putting underneath it a cardboard strip. This allows slipping a piece of paper underneath the edge of the celluloid. The spring clip holds the celluloid strip firmly down on the paper, so that it serves both as a clamp and as a straightedge. The celluloid strip is, of course, fastened exactly at right angles to the strip along the sides.

By using a large triangle for long lines and a little one for working close in the corners, as shown on the sketch, the device is converted into a miniature drafting machine. Two copies of pencil sketches can readily be made by using carbon paper.

Special Stake Holds Grade Line at Known Height Above Curb

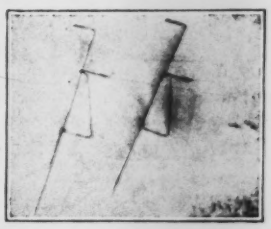
BY E. EARL GLASS
Monrovia, Calif.

LOOSE wire brackets on the steel rods shown in the photograph hold the grade line at a known height above the curb or form, and reduce the mental arithmetic required in measuring down with a rule to see whether the crown of the pavement is being accurately made. Those shown were made by the writer for the use of inspectors on concrete road construction.

The steel rods are pushed into the ground behind the

STAKE HOLDS STRING AT EXACT HEIGHT ABOVE CURB

form on each side of the road with the loose wire bracket resting on top of the form. The line between them when stretched tight thus forms a taut straightedge with a known offset. The device can be used as well for checking the subgrade as for making sure that the finished paving is struck to the proper crown. One man can use it readily, while two or more may be required to handle a heavy strike-board. The brackets shown hold the line 6 in. above the top edge of the form.



A Pair of New Kinks with Backfillers

WEIGHT of spoil bank increased the trouble from slips in trenching through soft ground for the sewers at Camp Custer, near Grand Rapids, Mich. The trench was not sheeted, and the toe of the spoil bank deposited by the trenching machine came to the edge of the cut. To reduce the trouble a backfiller of the dragline type was used behind the trenching machine to move the material farther back, leaving a berm between the bank and the trench.

In filling sewer trenches for the Speedway Realty Co., at Indianapolis, Ind., the backfiller was placed on top of the spoil bank and traveled along it in order to avoid obstructing the roadway on the outer side. The machine used was of the dragline type, with a 2-yard bucket.

Timber Cut in British Columbia Breaks Record

Last year the cut of timber in British Columbia amounted to more than 1,500,000,000 ft. b.m., which is an increase of 45% over the total for the preceding year, and about 100% more than the cut three years ago. The increase has been caused by the demand for material for airplanes and ships.

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Engineering Council Creates Three New Committees

Three committees were created or authorized by the Engineering Council at its bimonthly meeting Apr. 18. A water conservation committee will study the utilization and conservation of water for municipal supply, power development, irrigation, sewage disposal and navigation. A military aid committee will deal with activities ranging from supplying the needs of engineering units in training camp or combatant service to assisting the Government authorities in recruiting special engineering units or utilizing military engineering units on public works after the war. Prof. G. F. Swain, chairman; E. W. Rice, Jr., C. T. Main, A. C. Humphreys and B. B. Thayer constitute a special committee appointed to give immediate attention to the provisions in the Army and Navy appropriation bills to abolish bonuses.

C. A. Terry, chairman; C. A. P. Turner, C. T. Purdy, J. Parke Channing, H. V. Winchell, E. J. Prindle, D. S. Jacobus and F. N. Waterman have been appointed members of the patents committee created at the February meeting.

On recommendation of the public affairs committee, of which Charles Whiting Baker is chairman, a resolution was passed urging authorities of engineering schools to direct all their resources to the winning of the war—by relieving from routine work teachers in war work; by crediting students assisting in such work, and relieving them of prescribed work of less importance; by offering shops and laboratories for the solution of war problems, and by training undergraduates in the fundamentals of engineering even at the sacrifice of specialization on non-war subjects.

The question of licensing or registering engineers was referred to the public affairs committee.

Boston Public-Works Department Has Been Reorganized

Reorganization of the Boston department of public works into four instead of two divisions has been made by Col. Thomas F. Sullivan, whose confirmation as commissioner was noted in *Engineering News-Record* of April 18, p. 792. The former highway division, which included the supervision of sewers and water, will be broken into three divisions. The new sewer and sanitary division will be headed by Edward F. Murphy, recently commissioner of public works. The water-works will continue in charge of Frank A. McInnes and the highways will remain under the direction of James H. Sullivan. The old bridge and ferry division, headed by John E. Carty, will remain unchanged.

Barge Canal Operation to Be Centered in New York

G. A. Tomlinson, Federal Director, Has Large Authority—State Still Maintains Canal

During the past week the Director General of Railroads definitely assigned control of the New York State Barge Canal in the following order:

"G. A. Tomplinson is hereby appointed general manager of the New York Canal Section of the United States Railroad Administration and as such will have charge of the construction and acquisition of equipment for use upon the New York State Barge Canal and, as an incident thereto, for use upon the waters connecting therewith, and will operate such equipment for the Director General of Railroads upon such canal and other waters.

"He is hereby empowered to enter into contracts, either in his own name as such general manager or in the name of the Director General of Railroads, for the construction, acquisition or chartering of such equipment, for the purchase of supplies needed in such operation and for the transportation of property upon such canal and other waters."

Mr. Tomlinson has opened offices in New York City. According to the arrangement made with New York State, the railroad administration will have charge only of the transportation facilities on the canal, the maintenance of the waterway and the operation of the locks remaining in control of the Superintendent of Public Works.

Progress is being made on the design of the steel barges, on which bids will soon be asked. These are not to be operated in groups with one laden barge power equipped, as announced last week in these columns, but for the time being at least will be tug controlled. The first barge to be built will be comparatively small, 150 ft. long, 21 ft. beam and 12 ft. deep, and will have a carrying capacity from 400 to 500 tons. Concrete barges are being considered, too, but their design is not as far advanced as is that for the steel barge.

Renewal of Building-Trades Labor Contracts at Chicago

Recent negotiations in Chicago between the various contractors' associations and the labor unions for renewing expiring contracts have been marked by considerable advances in wages and in some cases by disagreement.

The wages for journeymen carpenters have been advanced to 80c. per hour. The agreement is for three years, expiring May 31, 1921. It is reported that the labor element dominated the negotiations in the making of this contract.

The painters of Chicago are on strike, refusing to sign the uniform agreement. It is said that a movement is on foot to organize another painters' union which would be recognized by both the Chicago Building Trade Council and the Building Construction Employers' Association.

It is expected that the dispute over renewing the contract of the electrical workers, elevator constructors, etc., will be long drawn out. It is understood that it may be necessary to revive Electrical Workers' Union No. 1 in order to settle the difficulty.

Plasterers have signed up a three-year agreement allowing $6.50 per day. Plasterers' laborers have signed a three-year agreement at $4.50 per day. Bricklayers have been advanced to $6.50 per day with a three-year agreement. Common laborers have been allowed 50c. per hour with a three-year agreement.

Electrification of Switching Railroad at St. Louis

Electric traction is to replace steam on a portion of the Manufacturers' Ry., St. Louis, Mo., because it is considered undesirable to operate steam locomotives on the tracks entering the buildings of the new Bevo plant, described in *Engineering News-Record* of Oct. 25, 1917, p. 772. The use of electric locomotives was adopted mainly to eliminate the smoke nuisance, and at the same time to reduce the cost of labor and maintenance.

The Manufacturers' Ry. consists primarily of industrial switching yards and interchange connections with other railways. It has 22½ miles of line and five steam locomotives. The electrification will cover the yard at the Bevo plant and the section of line connecting this with the interchange yard. It will include about ten miles of track, having a maximum grade of 5% and a maximum curvature of 36°. There will be two General Electric eight-wheel 80-ton locomotives.

Alternating current of 13,200 volts from the Keokuk hydro-electric plant will be supplied by the Union Electric Light & Power Co., and will be transformed and converted into 600-volt direct-current.

Installation is being done by the Gilsonite Construction Co., St. Louis, Mo. This is under the direction of C. E. Smith, consulting engineer for the work, in whose office the detail plans were prepared. It is expected to have the line in operation by July. W. Cotter is president and general manager; Hollis Marsh is chief engineer of the railway.

Capital Issues Committee Shows Saving of 37.8 Per Cent

During the week just passed the Capital Issues Committee disposed of 25 applications, aggregating $10,105,000, of which $762,000 were disapproved. The $9,343,000 approved included $300,000 of refunding obligations, so that the new issues approved aggregated $9,043,000. New issues for the corresponding period last year amounted to $14,547,000, so that a comparative saving of 37.8% was effected. In addition to this saving, postponement was secured informally of issues aggregating $5,560,000.

The committee reports that security issues of municipalities comprise the major portion of the matters considered by the Capital Issues Committee. It announces that Surgeon General Blue, of the United States Public Health Service, has placed his organization at the disposal of the committee for use in connection with the consideration of capital expenditures for the purpose of making sanitary improvements.

Track Elevation at Indianapolis to Be Continued

Congestion of street traffic in Indianapolis, due to partly completed work on the track elevation in the center of the city, is so serious that the United States Government has authorized continuance of the work. Some main streets are closed entirely, necessitating long detours and concentrating traffic on other streets where grade crossings cause frequent interruptions. These conditions apply especially to the heavy teaming to and from the freight terminals.

Improvement of these crowded streets cannot be undertaken until the separation of grades relieves the situation. Progress has been delayed considerably during the past two years, but by the end of 1917 about 35 per cent. of the work had been done.

The present permit provides for about 50 per cent. more, so that the work may be 85 per cent. completed under present conditions. It includes elevating the tracks through the Union Station, with the removal of the old steel trainshed and the erection of a concrete and steel structure. The station building at the side of the tracks will be left intact. The total cost of track elevation at present prices, including terminal facilities, etc., approximates $15,000,000.

Provide Forum for 250 Society Delegates

Coördination of engineering society activities will be the main topic of discussion May 14 at the annual convention of the American Association of Engineers meeting jointly with the Committee on Engineering Coöperation. Delegates from 250 national, state and local societies have been asked to attend this forum, the main idea in mind being "What More Can Engineers Do to Win the War?"

To assist the delegates in their survey of society service all societies have been requested to submit answers to 24 questions on society activities, war programs, employment features, education and publicity.

The following speakers are on the program: Major Gardner S. Williams, E. T. Perkins, C. E. Drayer, Col. Charles S. Riché, Corps of Engineers, Alfred D Flinn, secretary Engineering Council, and W. H. Finley, chief engineer, Chicago & North Western Railway.

St. Louis Water-Works Special Changes Route and Time

Important changes in the route and time of the special transportation facilities for journeying to the convention of the American Water-Works Association, at St. Louis, May 13-17, have been forced upon the committee in charge since a circular bearing on the subject was mailed to the members. Instead of leaving Saturday morning over the Lehigh Valley those who wish to enjoy traveling together will leave the Pennsylvania Terminal, 33d St. and 7th to 8th Aves., New York City, at 2.04 p.m., and the Hudson Terminal, downtown, at 2.00 p.m., Saturday, May 11. The leaving time at other points on the Pennsylvania will be: Philadelphia, 4.30 p.m.; Harrisburg, 7.10 p.m.; Pittsburgh, 12.35, midnight; Indianapolis, 11 a.m., Sunday. The train is due in St. Louis at 5.25 p.m., Sunday.

To insure entire Pullmans for the party it will be necessary for some to occupy upper berths, under a Federal Government ruling now in force.

Reservations from the New York and Philadelphia districts may be made through W. H. Van Winkle, 50 Church St., New York City. For the section between Syracuse and Cleveland, those desiring reservations should communicate with L. S. Barnard, care Hersey Meter Co., Buffalo, N. Y.; for western Pennsylvania and Ohio, with T. C. Clifford, Pittsburgh Meter Co., Pittsburgh, Penn.; for the southern district, H. M. Lofton, Columbian Iron Works, Chattanooga, Tenn.

Free Port Legislation Postponed

The Ways and Means Committee of the House of Representatives announced Apr. 24 that it had agreed not to consider at the current session any legislation to establish free ports in the United States. As announced in these columns some weeks ago a bill authorizing the Government to approve such free ports had been introduced in Congress.

Government Selects Two Yards for Concrete Ships

Agency Contracts Let at Wilmington, N. C., and San Francisco—Other Ships and Barges Progressing

(Washington Correspondence)

The Emergency Fleet Corporation has let contracts for two shipyards where concrete ships are to be built under the agency plan, and has under way an investigation of other sites where three other yards will be located, provided Congress appropriates the $50,000,000 made available by the McCumber bill, now in the hands of the Senate Committee on Appropriations. The two yards selected are at Wilmington, N. C., where the Liberty Shipbuilding Co., Boston, has been awarded a contract for eight ships, and San Francisco, Cal., where the San Francisco Shipbuilding Co. has a contract for one ship. A committee of engineers from the Fleet Corporation is now completing a tour of the available sites for the remaining yards.

Government Owned Plants

Both of the plants will be Government owned yards, built and operated by the contractor as agent for the Government. The Liberty Shipbuilding Co. Already had a contract with the Government for the construction of 50 concrete ships, contingent upon the acceptance of the first ship turned out. Under this contract it is building a 3500-ton ship at a yard at Brunswick, Ga. This ship will be carried to completion, but the old contract has been cancelled in favor of this new one, which is for eight ships, some to be the standard 3500-ton ship designed by the Fleet Corporation and some to be 7500-ton tankers, now nearing complete design by the corporation. The Brunswick ship is well under way, the yard having been prepared and all the forms made ready for erection.

The San Francisco company is the one which recently launched the 4500-ton "Faith" and its contract calls for the construction of a yard and the building of one 7500-ton ship. The yard will not necessarily be the one where the "Faith" was built. That ship is now being rapidly fitted out and should be ready for its trial trip in May.

One Contract Lapses

One of the three existing contracts for concrete ships has been allowed to lapse by its holder, the Ferro-Concrete Shipbuilding Co. This company intended to build the ships at Redondo Beach, Cal., but it did not comply with some of the preliminary requirements of the contract. The other contract, that held by the Fougner Concrete Steel Shipbuilding Co., is progressing. The company has located a yard on Flushing Bay, Long Island, and should soon be at work on the 3500-ton ships prescribed.

Experiments on stresses in concrete members, aggregate and stresses and

strains in ships are making satisfactory progress. Large size reinforced-concrete test pieces designed to reveal shear stress conditions have been made and tested at Pittsburgh and the results are about to be made public. Studies on light-weight aggregate give promise of some useful conclusions, particularly in the way of using small hollow clay pieces and an artificially-produced porous clay. Some special recording strain gages have been built and have been tested on trips on steel vessels between New York and Boston. These gages give continuous records of strains in selected locations of the ship's frame at the same time that continuous records are made of the hydrostatic pressure at numerous places on the hull. These latter are made from pressure gages, mounted in the plating, which record the height of wave outside the ship. Thus it is possible to coördinate stress and load in a way which has never before been attempted in ship design.

A committee of three from the Fleet Corporation, consisting of F. R. McMillan, H. R. Loeffler and L. Brush, have gone to San Francisco to take such measurements on the maiden trip of the "Faith." Plugs are being placed in the frame of the Brunswick ship to facilitate the measurements on that vessel when it is being launched and tested.

Some additions have been made to the staff of the concrete ship division. Lewis R. Ferguson, who was assistant chief engineer, has resigned to become general manager of the Liberty Shipbuilding Co., which is building the ships at Brunswick and Wilmington. Mr. Ferguson will make his headquarters at Wilmington. His place has been taken by H. J. Brunnier of San Francisco. As a specialist on the design and construction of forms, the aid of S. C. Beane, who holds a similar position in the Aberthaw Construction Co., of Boston, has been enlisted by the division. E. C. Noyes, formerly of the Truscon Co., at Los Angeles, is in charge of plant; W. P. Richardson, the ceramic engineer, is investigating the possibilities of clay aggregate, and G. W. Coggeshall, Washington, D. C., is studying paints for the hull of the ships.

In design work the division is assisting the inland waterways committee of the railroad administration by designing and studying various barges, for the New York State Barge Canal, the Mississippi River and the Warrior canal and river system.

Third Nitrate Plant Goes to Ohio

Announcement has been made by the War Department that the third Government nitrate plant will be divided into two parts, to be situated at Toledo and Elizabethtown, Ohio. Each will be a half unit, the two being equal to the full unit now being constructed at Sheffield, Ala., and known as Plant No. 2. Plant No. 1 is also at Sheffield, but is much smaller than the other two units.

Courses to Train Technicians and Mechanics for Army Service Begun

7500 Men Now in Schools—90,000 to be Trained This Year—Men on Draft Rolls Volunteer for This Work

Last February the Secretary of War appointed a Committee on Education and Special Training, charging it with the responsibility of training 90,000 men of the National Army for technical and skilled work of various kinds. The army is in need, for example, of motor truck drivers, airplane mechanics, carpenters and blacksmiths. The selective draft methods proving inadequate to supply this demand, the committee was formed to arrange for intensive training.

Educational plants equipped for handling large numbers of students were obviously the machinery that should be adapted to this work. So rapidly has the committee proceeded that 25 schools are now under contract to take the men, 14 schools have begun their work and 7500 National Army men are under instruction. The number of schools will be increased until 30,000 men can be instructed at one time. The courses are of eight weeks' duration, and the final lot of 30,000 men (for army needs as planned at the minute) will go to the schools Sept. 1.

One School to Take 2500

In arranging for the work institutions were preferred that could accommodate at least 500 men. One school expects to take 2500. The institutions include engineering colleges, universities and mechanics' institutes, while in one city the public school system is being used. The number of different courses given at an institution depends on various conditions—number of students, character of school equipment, location, and the like. One school, the University of Virginia, will specialize in the training of motor truck drivers, and will take 600 men at a time. For the truck-driving courses, such automobile equipment will be used as is available, and the Government, in addition, will furnish one army truck for each 20 men.

Army officers will be placed at each school, and military drill will be carried along simultaneously with the technical instruction. The technical staff will be supplied by the institution, and, with the army officers, will form a board to direct the administration.

The curricula used are those outlined for intensive training by the Federal Board for Vocational Education, although the staff at each school has much latitude in the presentation of essential matter. At some schools coöperation with the local industries is being arranged, as, for example, in the instruction in rubber vulcanizing at Akron, Ohio. At present the following courses are arranged for: Auto driving and repair, bench wood work, general carpentry, electrical communication (telephone and telegraph work), electrical work, forging and blacksmithing, use of gas engines, machine shop work and sheet metal work.

Students are Volunteers

While the men at the schools are National Army men and come through the draft boards, they volunteer for this special training. The provost marshal general sends out a call to the boards for men with experience fitting them for the lines in which the training is to be given, and are asked to certify volunteers from their rolls. In other words, the men go to the schools directly from their homes and are not drawn from the cantonments. As a result of this volunteer system men of high grade have been obtained.

The men are required, in addition to their experience, to have had a common school education—although this is not a hard and fast rule. Aptitude and ability to learn are the chief requirements.

Under the plan of selection by the local draft boards the results have not always been of the best. Men have been sent to one school who should have gone to another. To insure proper assignment a plan is now being worked out whereby all men will be sent first to a number of "reservoir" schools, where they will be tested by qualified men and then assigned and sent to the proper schools. In the courses themselves the aim will be to push men along as fast as their abilities warrant. Journeymen machinists, for example, will immediately be put on highly specialized work, such as airplane repairs.

Accommodations Mainly by Schools

All men are ranked as enlisted privates and are paid accordingly, and, of course, their outfits are supplied by the Government. The schools, as a rule, contract for the housing, feeding and instruction for a lump sum per man per day, but in some cases the housing and feeding will be done by other parties. In arranging for accommodations the Quartermaster Department has been of invaluable assistance, furnishing cots and other equipment to institutions having the buildings, but lacking the necessary dormitory and dining room equipment. All sorts of expedients have been used in places where building space was lacking except for the actual instruction. Armories have been converted, and in several cases fair grounds have been used.

To facilitate the work the country has been divided into ten districts, the institutions in each coming, as to the technical instruction, under the direct supervision of a district director. These in turn are under the direction of the general educational director, C. R. Dooley, formerly of Pittsburgh. The

committee itself consists of three army officers, Lt.-Col. J. H. Wigmore, Lt.-Col. H. I. Rees and Major Grenville Clark. Assisting them is an advisory board consisting of Hugh Frayne, representing labor, and the following representatives of educational interests: J. R. Angell, the colleges; S. P. Capen, Federal bureau of education; J. W. Dietz, corporation schools; C. R. Mann, schools of pure science; Dean Herman Schneider, engineering schools.

President Nominates War Finance Board

Four Directors Named For Finance Corporation—Seven Members For Capital Issues Committee

President Wilson has taken the first step in the definite organization of the War Finance Corporation, by sending to the Senate nominations for four directors, who, with Secretary McAdoo, will be in charge of financing projects essential to the prosecution of the war. At the same time the President nominated seven members of the new Capital Issues Committee which will replace the Federal Reserve Board's Capital Issues Committee in regulating security issues of more than $100,000.

The directors of the finance corporation, nominated by the President, are as follows: For a period of four years, Eugene Meyer, Jr., banker, New York, and Angus W. McLean, banker, Wilmington, N. C.; for a period of two years, William P. G. Harding, governor of the Federal Reserve Board, Alabama, and Allen B. Forbes, banker, member of the present Capital Issues Committee, New York.

The members named for the new Capital Issues Committee are Charles S. Hamlin, member of the Federal Reserve Board, Massachusetts; John Skelton Williams, comptroller of the currency and member of the Federal Reserve Board, Virginia; Frederic A. Delano, member of the Federal Reserve Board, Illinois, James B. Brown, banker, Louisville, Ky.; John S. Drum, banker, San Francisco; Henry B. Flower, banker, Kansas City, Mo., and Frederick H. Goff, banker, Cleveland.

As soon as the directors of the War Finance Corporation are confirmed by the Senate, they will place the corporation on an operating basis, and it is expected that loans will be made within two or three weeks, as informal applications are already on file.

Railroad Administration Orders 1025 Locomotives

On Apr. 30 the railroad administration let contracts for 1025 standardized locomotives, the largest single order ever placed in the history of American railroads. The contracts were placed with the Baldwin Locomotive Works and the American Locomotive Co. It is understood that the entire order represents approximately $60,000,000.

The order includes locomotives of six newly-developed types—Mallet, mountain, Pacific, Santa Fé, mikado and switching—as in contrast with the hundreds of different designs used by the railroads before Government control.

High Prices Worry Water-Works Officials

Present and after-the-war prices of materials used in water-works construction formed the main topic of discussion at the seventh annual convention of the Southwestern Water-Works Assn., Apr. 23-26, at Tulsa, Okla. The register indicated that 36 superintendents and 43 supply men were in attendance.

R. E. McDonnell started the price discussion by his paper on "After-the-War-Prices of Water-Works Materials." Reasoning from the range of prices after former wars, he held out no hope that prices would be any lower for many years. Labor, its price and availability, will be the chief factor, because the war has already lasted long enough to set up new economic conditions that will not be abandoned when the war is over. Labor prices here and abroad will be more nearly equalized. Export trade in water-works materials will create a demand which will keep down the supply. The only hope held out came during the discussion, and that was from Government control.

Judge W. B. Garrett, owner of the Del Rio, Tex., plant, said that supplies simply would not be bought. The water-works men could not stand the pressure. Their franchise and financial agreements would not permit of normal extensions under any further increases.

The 20 to 50% increase in labor prices was not to be compared, in the opinion of many of the superintendents, with the 100 to 500% increase in matorial prices. The supply men asserted that the Government took the excess profit.

E. L. Fulkerson, secretary of the association, and superintendent at Waco, then turned the limelight of inquiry from the supply men by asking when higher water rates were going to be granted. More backbone, and education of the consumer and city councils, are badly needed, in his opinion.

"Operating Difficulties in Mechanical Filter Plants" was the subject which started a spirited discussion by the officials who have or contemplate having filters. C. Arthur Brown read a paper in which he pointed out on this tabooed subject the effects on operation of good or poor design, the absolute necessity of intelligent operators in either case and the serious consequences under indifferent operation. Some of his admonitions to designers are as follows: Meter the water to be treated, and do it after it leaves the forebay or receiving chamber. Do not split the flow until all chemical treatment has been given. Look out for sand and gravel inversion due to improper wash, which also will cause hard spots, mushy beds, mud balls and cracked beds. Mr. Brown does not favor "blowing" or short washing, but for an air-locked bed it may be done carefully and lightly at frequent intervals. The benefits of attrition allowed by the old-time rake filters he proposed to obtain by letting the sand when in suspension tumble into a V-shaped trough open at the bottom. The troughs are entirely above the sand surface when the sand is quiescent. The top is 4 in. below the wash-water gutter edge. As a result of experiments at Tulsa, the troughs have reduced the wash-water percentage materially by increasing the length of run. Patent has been applied for.

The question of pumping water by motor driven centrifugal pumps elicited many unfavorable remarks by the superintendents against public utility corporations which induce water-works officials to install electrically driven units to fill up the valleys in their load curves only to find their power bills enormously increased over former bills for steam pumping.

The officers elected for the ensuing year are as follows: President, Judge W. B. Garrett; vice-presidents (one for each state in the association), L. I. Kahn, Louisiana; G. E. Ulrich, Kansas; J. Kirven, Texas; R. D. Cockrell, Oklahoma; V. L. Landreth, Missouri; J. M. Hudgin, New Mexico; M. F. Smith, Arkansas. Kansas City gets the next convention, outdistancing Taylor, Tex., by a very small majority of votes.

A growing sentiment favoring affiliation with the American Water-Works Association exists, and a few members were under the impression that some sort of agreement is already in effect. This subject is discussed in our editorial columns this week.

Engineers Ballot on Civic Questions

To arouse engineers in Chicago to a greater sense of their civic duties and to get them to thinking on these questions the Chicago chapter of the American Association of Engineers recently sent its members a ballot on five subjects which were not elaborated upon or qualified in any way. The chapter has about 650 members but only 110 voted. The results were as follows: For national prohibition, 88%; for national women's suffrage, 92%; for city manager plan for Chicago, 96%; for an engineer in city council, 99%; for engineer for smoke inspector, 100%.

Kansas City Construction Work Resumed

Under an agreement reached between the Employers' Assn., Kansas City, Mo., and employees in the various building trades, construction work was resumed on April 24 after having been stopped for about five weeks. This permits continuance of construction of the foundations for the new power plant of the Kansas City Light & Power Co. The city says that work will be pushed night and day in order to complete the structure by next fall if possible. It

is still uncertain whether the company will be able to obtain from the Federal Government the authority required to secure the necessary equipment for the plant. Need for the installation is said to be great because the large increase in the demand for power has overtaxed the plant of the company. A note on the Kansas City building trade tie-up, which began with a strike of laundry wagon drivers, appeared in *Engineering News-Record* of Apr. 11, p. 734.

Will Re-Let Erie Flood Control Channel Work

New bids are asked by the city of Erie, Penn., on the Mill Creek channel improvement for flood control. This follows the recent court decision voiding the contract on which work has been proceeding, for the reason that all the bonds had not been sold and the contract not properly certified. About $300,000 is on hand, and the work now to be put under contract can be constructed for this sum. It includes the upper end of the improvement and the outfall, and should be completed during the current season. The work to be let includes 3500 ft. of reinforced-concrete conduit, 18 x 22 ft. inside, involving about 36,000 cu.yd. of excavation, mostly rock, and 15,000 cu.yd. of reinforced concrete. Faulkner G. Lynch is city engineer, and Gannett, Seelye & Fleming, Harrisburg, Penn., are consulting engineers.

Liberty Loan Advertising in the Chicago City Hall

Readers may be interested to know that all of the Liberty Loan advertisements which appeared in the Apr. 11 issue of *Engineering News-Record* were reused for Liberty Bond advertising in the Chicago City Hall.

ENGINEERING SOCIETIES

The 38th annual convention of **The American Water-Works Assn.** will be held May 13-17, in St. Louis. Headquarters will be established in the Planters Hotel, with provisions made for the overflow in the American Annex. On the evening of the first day the association will be welcomed to St. Louis by H. W. Keil, mayor of the city, and there will be a reception and dance at the Planters Hotel. The forenoon session of Tuesday, May 14, will be devoted to the address by President Leisen, an illustrated lecture on "Emergency Construction Due to War Conditions," by George W. Fuller, reports of committees and announcement of the award of the cup to the section which made the greatest percentage of increase in membership, 1917-1918. At the evening session, as in other sessions, forenoon, afternoon and evening, papers on a wide variety of topics will be read and discussed. Entertainment features have been planned for afternoon and evening sessions and the local committee has planned to pay especial attention to the entertainment of the ladies who will accompany members. Thursday, May 16, will be "Superintendents' Day." A complete program of the convention may be obtained from John M. Diven, secretary of the association, 47 State St., Troy, N. Y.

Calendar

Annual Meetings

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; May 13-18, St. Louis, Mo.

AMERICAN ASSOCIATION OF ENGINEERS; 29 South La Salle St., Chicago; May 14, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS; 29 West 39th St., New York; Spring meeting, June 4-7, Worcester, Mass.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS; 129 York St., Brooklyn, N. Y.; June 19-22, Berlin, N. H.

AMERICAN CONCRETE INSTITUTE; 27 School St., Boston; June 24-26, Atlantic City, N. J.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 25-28, Atlantic City, N. J.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; 29 West 39th St., New York; Atlantic City, June 26-28.

At a luncheon meeting of **the San Francisco Engineers' Club** Apr. 19, Lieut. James S. Dagger, of the Canadian Expeditionary Forces, delivered an address on "The War on the Western Front" and "Labor and Its Relation to War."

At a recent annual meeting of **the Illinois Section of the American Water-Works Assn.**, the following officers were elected for the ensuing year: Chairman, W. W. DeBerard; vice-chairman, W. E. Lantz; treasurer, H. E. Keeler; trustees, F. C. Amsbary and H. M. Ely. G. C. Habermeyer, Urbana, Ill., is secretary.

The Engineers' Club of Trenton, N. J., held a special meeting Apr. 25 at which T. Kennard Thomson, consulting engineer, New York City, presented a paper entitled: "Some Problems of a Consulting Engineer," illustrated with lantern slides. The paper dealt with the subject of deep foundations, the tearing down of a 17-story building, a Niagara Falls junior power development, and the evolution of a city.

At the meeting on Apr. 25 of **the Canadian Society of Civil Engineers**, held in Montreal, the speakers were U. Valiquet, superintending engineer, Department of Public Works, Ottawa, and Lieut. Philip Bruneau, of the Canadian Machine Gun Corps, on furlough. Mr. Valiquet's paper on the "Champlain Dry Dock for Quebec Harbor," was presented. The subject of Lieut. Bruneau's address was "Machine Gun Work in Flanders." Having lately returned from the front, Lieut. Bruneau presented a vivid description of this vital and highly dangerous branch of the service.

The San Francisco Association of Members of the American Society of Civil Engineers held its bimonthly meeting Apr. 16; Frederick H. Fowler, hydraulic engineer, U. S. Forest Service, presented an illustrated address on "Review of the Water Power Supply of California." Another speaker was Lieut. L. L. Johnson, U. S. Marine Corps, who spoke on "Engineering Problems at The Front."

A meeting of **the Engineers' Club of Kansas City** was held Apr. 20. A. G. Heggem, engineer for the Tulsa Securities Corporation, Tulsa, Okla., presented a paper on oil, its production, selection, refining and distribution. At the dinner following the meeting the members of the club joined in a general discussion of the speaker's paper. Capt. John H. Byrd, now stationed at Camp Funston, Kansas, gave a talk on the work of engineers in the training camp.

The **Nebraska Assn. of Members of the American Society of Civil Engineers** will make a trip of inspection today, from Lincoln, of the work being done by the Chicago, Burlington & Quincy R.R. at the Platte River bridge near Grand Island.

PERSONAL NOTES

GEORGE McCUNE has been appointed city engineer of Leavenworth, Kansas.

ALBERT SPENGLER, civil engineer, San Francisco, has been appointed captain in the Quartermasters Corps.

ROLAND TONER, formerly superintendent of the Frank Farrington Co., Detroit, has been made superintendent for the J. G. White Engineering Corp., New York, of the Aeronautical Experimental Station at Langley Field.

ALBERT P. LEARNED, for five years assistant engineer with Black & Veatch, consulting engineers, Kansas City, has been commissioned first lieutenant in the sanitary corps of the National Army and stationed at Camp Greenleaf, Chickamauga, Georgia.

FRED M. CLECKNER, of the staff of Gannett, Seelye & Fleming, Harrisburg, Penn., has joined the aviation section of the signal corps and has been assigned to special engineering research at Camp McArthur, Waco, Tex. This makes a total of ten men from the above firm who have joined the colors. Paul D. Ryan of Wash-

ington, D. C., and C. J. Hellen, of the Southern R.R., have joined the staff of Gannett, Seelye & Fleming. Mr. Ryan is a graduate of the University of Michigan and has been connected with various industrial and electrical organizations. Mr. Hellen is a graduate of Lehigh University. He has been employed by the Baltimore Sewerage Commission, the Baltimore & Ohio R.R., and the Southern Railway.

ROBERT S BEARD, assistant city engineer, Kansas City, Mo., has passed his examination for a captaincy in the quartermaster's department, for construction work. Mr. Beard will resign his position with the city upon the arrival of his commission.

E. A. KEMMLER has been appointed engineer in the division of highways, Akron, Ohio. Mr. Kemmler was graduated from the Ohio State University in 1888, and from 1891 to 1895 he was assistant professor of civil engineering at the university. From 1895 to 1908 he was assistant engineer and later resident engineer with the City of Columbus, Ohio; 1908 to 1910, supervising city engineer, Muskogee, Okla.; 1910 to 1915, assistant engineer, Akron Water-Works; 1916 to date, chief engineer, Coventry Land & Improvement Co., Akron, Ohio.

GANNETT, SEELYE & FLEMING, engineers, Harrisburg, Penn., have been appointed consulting engineers on water-works and sewerage for the new quartermaster's depot near Harrisburg.

D. L. SOMMERVILLE, superintendent of the Mohawk division of the New York Central R.R., and formerly division engineer at Buffalo, is to be transferred as superintendent of the Rochester division.

E. D. BARSTOW has been made assistant engineer in charge of field survey on sewerage investigation, City of Akron, Ohio. Mr. Barstow was graduated from the Ohio State University in 1907; was with Riggs & Sherman, consulting engineers, Toledo, Ohio, from 1907 to 1911; 1912 to 1913 he was assistant engineer, City of Toledo, and from 1913 to 1915, assistant engineer with R. Winthrop Pratt, consulting engineer, Cleveland, Ohio; 1915 to 1918 he was engineer of Cuyahoga Falls, Ohio.

JOHN L. BOARDMAN, formerly superintendent of the new terminal station at Jacksonville, Fla., has been placed in charge of the construction of the Langley Field Aeronautical Experimental Station and the Aerial Observation School attached thereto, for the J. G. White Engineering Co., of New York City.

MAJ. W. MORAVA, quartermaster corps, U. S. R., has been appointed constructing quartermaster on the quartermaster's storage depot to be erected near Harrisburg, Penn., at a cost of several million dollars. Major Morava comes from the Morava Construction Co., of Chicago, bridge and structural steel engineers and builders, of which company he is president. Major Morava's assistants will be Capt. L. H. Waggoner and Lieut. K. H. Talbot, the latter a former district engineer for the Portland Cement Assn. at Pittsburgh, who has been in charge of the preliminary field engineering at the site of the depot for several weeks.

H. G. MCMECHEN, chief engineer of the Utah Ry., has resigned. His duties have been assumed by O. J. Egleston, vice president and general manager.

L. B. WEBB has been appointed county engineer of Doniphan County, Kansas, with office at Troy.

WILLIAM NEWMAN, naval architect, has resigned his position as works manager of the Polson Iron Works and Steel Shipbuilding Co., Toronto. Mr. Newman, who during his connection with the Polson Co. has supervised the construction of 54 vessels, has received offers from the United States Emergency Fleet Corporation, and from shipbuilding companies on the Pacific Coast and at Port Arthur, but has not decided which he will accept.

LEE M. BUSH has resigned as junior civil engineer, Interstate Commerce Commission, division of valuation, western district, to become assistant engineer for the Missouri, Kansas & Texas Ry. He has been with the commission on the valuation work since its beginning in 1914.

R. R. YATES, who has been in charge of bridge designing in the office of the city engineer of Dayton, Ohio, has been commissioned junior lieutenant in the navy.

G. B. ARTHUR, district engineer in West Virginia for the Portland Cement Assn., has resigned to become general manager of the Concrete Mixer Assn., with headquarters in Chicago. Mr. Arthur has been in West Virginia on road work since the very beginning of the road movement in the state, and has been with the association for over two years as district engineer. In resigning from the Portland Cement Assn., Mr. Arthur recommended that J. W. Johnston, who has been his assistant, be appointed district engineer. Mr. Johnston has been connected with the association for two years.

JAMES MCKENZIE has been appointed county engineer of Morris County, Kansas, with office at Council Grove.

R. G. COLLINS, constructing engineer, New York, has established an office in Baltimore. Mr. Collins has been identified with the construction of large works in New York, having had supervision of the Pennsylvania Terminal construction and of several sections of the subway. Recently he has been specializing in the construction of concrete highways, and is now engaged in building concrete highways for the United States Government and for the State of Maryland.

CHARLES R. AMMERMAN, of Ammerman & McColl, engineers, Detroit, has received a commission as captain in the construction division, Quartermaster's Reserve Corps, and has been assigned to duty at Camp Custer, where he has been making a survey of the heating plant.

H. S. WILGUS, engineer of maintenance of way of the Pittsburgh, Shawmut & Northern R.R., has been appointed chief engineer.

VICTOR H. COCHRANE, engineer of bridges of Kansas City, Mo., has been appointed major in the quartermaster corps, National Army, and has been assigned to duty in connection with the construction division, Washington, D. C.

B. T. THOMAS assumed charge Apr. 24 of the Second Cincinnati Engineer District, after nearly 35 years' service therein as assistant engineer. He succeeded Col. W. P. Stokey, engineer corps, who was transferred to San Antonio, Tex. The district of Mr. Thomas, whose new title is district engineer, includes the Muskingum, Big Sandy and Kentucky Rivers.

GARRETT O. HOUSE, general superintendent of the Bureau of Water, St. Paul, for the past six years, has resigned to become superintendent of the St. Paul City Railway. Mr. House was born at Haverstraw, N. Y., and until 1904, when he moved to St. Paul, was engaged in civil engineering work in New York State, beginning with his experience on the construction of the Poughkeepsie Bridge in 1888. He was acting city engineer of Poughkeepsie for several years and assistant engineer under the state engineer engaged in the enlargement of the Erie Canal and state highway construction until 1902, when he associated himself with the American District Steam Co., Lockport, N. Y. In this capacity he went to St. Paul in 1904 and established the public utility corporation now known as the Northern States Power Co., in St. Paul. In 1909 he was associated with G. H. Hutchinson, chief engineer, North Western Fuel Co., in the installation of electrically operated coal docks at Superior, Wis. From 1912 to date, he has been general superintendent of the water department of St. Paul.

BENJAMIN L. SMITH, who has been connected with the American International Shipbuilding Corporation, is again associated with the Baltimore office of Norton, Bird & Whitman, consulting engineers. Since last November Mr. Smith has been engaged as assistant to H. H. Barter, engineer of utili-

ties, who was in charge of the design of the domestic water system, high-pressure water system for fire protection and sewage system for the Government shipyard at Hog Island, Pennsylvania.

CLARENCE GOLDSMITH, whose services during the past year have been contributed by the National Board of Fire Underwriters to the Government as advisory engineer on water supply and fire protection, has been commissioned as major in the Quartermaster Corps, construction division, of the National Army.

DONALD M. RANKIN, of the office of B. M. Buck, division engineer of the Atchison, Topeka & Santa Fé Ry., at Topeka, Kans., was inducted into the military service when Topeka was called upon to furnish a civil engineer. Mr. Rankin was assigned to the science and research division of the aviation section of the signal corps at Camp McArthur, Waco, Texas.

GEORGE F. MARTIN has resigned as chief engineer of the R. Munroe & Sons Manufacturing Corporation, Pittsburgh, to become construction engineer for the Bureau of Mines, at the American University, Washington, D. C. The partnership of Kolman & Martin, engineers and architects, Pittsburgh, of which Mr. Martin is a member, will be dissolved.

W. HERVEY HALL, formerly of Yalaha, Fla., has been engaged as assistant city engineer of Florence, Ala.

ROBERT H. BOYKIN, division engineer of the Erie R.R. at Susquehanna, Penn., has been appointed assistant superintendent of maintenance, with headquarters in New York City, filling the place of H. Knight, who has been promoted.

CHARLES M. LEWIS, assistant division engineer at Susquehanna, becomes division engineer, succeeding Mr. Boykin.

SHELBY S. ROBERTS, consulting engineer, Chicago, has been appointed to the staff of the regional director of Southern railroads, Atlanta, Georgia.

G. H. JENNINGS, assistant chief engineer of the Elgin, Joliet & Eastern Ry., has resigned to become general manager of the Powers-Thomson Construction Co., of Joliet. F. J. Masters, division engineer, succeeds Mr. Jennings as assistant chief engineer.

HARRY K. ELLIS has been appointed assistant engineer in the Bureau of Highways, Department of Public Works, Philadelphia. Since October, 1915, Mr. Ellis has been connected with the Department of City Transit as assistant engineer in charge of design.

LE ROY H. BYAM has resigned as secretary and treasurer of the Elliot C. Brown Co., general contractors and engineers, New York City, to accept a commission as captain in the Engineers' Reserve Corps, and has been ordered to 55th Engineers, Camp Custer, Battle Creek, Mich. Mr. Byam was previously connected with the engineering staff of the New York Central Railroad Company, in charge of construction work in the electric zone between New York City and Harmon.

SCOTT B. LILLY, formerly assistant plant engineer of the Merchant Shipbuilding Corporation, Bristol, Penn., and the Structural Shipbuilding Co., Ltd., Bristol, Penn., and Carroll Beale, formerly chief designer for both the Merchant and Structural companies, have organized the firm of Beale & Lilly, Inc., for the purpose of conducting a general engineering business. They will specialize in the design and construction of shipyard plants, ship terminals, industrial and housing developments. The address of the new firm is 1011 Chestnut St., Philadelphia.

J. E. GOVERN has been selected as government supervising engineer on the large quartermaster's storage depot on which work has just been commenced near Harrisburg, Penn. Mr. Govern was formerly assistant chief engineer of the Buffalo, Rochester and Pittsburgh R.R. and previous to that he was division engineer on the New York State Barge Canal. He was government supervising engineer on one of the large cantonments in the South.

H. F. FRENCH is the new designing engineer, division of sewerage, City of Akron, Ohio. Mr. French was graduated from Purdue University in 1912; from 1912 to 1914 he was assistant engineer, sewerage investigation, City of Cincinnati; 1914 to 1915, assistant engineer on valuation of Bay State R.R.; 1915 to 1916, engineer of the Cincinnati Bureau of Research; 1916 to 1917, assistant engineer, Firestone Tire and Rubber Co.; 1917 until his recent appointment, assistant engineer on design, Akron Water-Works.

J. EUGENE ROOT has resigned as assistant engineer in charge of design and records of the division of sewerage, Cincinnati, to become engineer in charge of the division of sewerage, department of public service, of the City of Akron, Ohio. Mr. Root, who was graduated from Pennsylvania State College in 1907, has held the following positions: From 1907 to 1908 with the Southern Pacific Ry.; 1908 to 1912, instructor in civil engineering at the University of Cincinnati; 1912 to date, assistant engineer, division of sewerage, City of Cincinnati.

HERBERT H. EVANS has been made district sales manager of the Coatesville Boiler Works, Philadelphia, with office in Philadelphia. From 1909 to 1912 Mr. Evans was connected with the American Bridge Co., and from 1912 to 1915 he was assistant engineer of design on the Hell Gate Arch Bridge. Since 1915 he has been engineer for the Coatesville Boiler Works.

OBITUARY

GEORGE CROCKER, civil and consulting engineer, died at his home in South Yarmouth, Mass., Mar. 11, in his seventy-third year. He was in active service nearly fifty-two years and was connected with many of the important projects of his time. His last work was with the Boston & Albany R.R., and at the age of seventy he was retired and pensioned by the New York Central Lines. In 1870 Mr. Crocker was chief of surveys, Northern Pacific R.R., and in 1871-74 locating and division engineer of the Baltimore & Ohio R.R. extension to Chicago. From 1879 to 1896 he was connected with various other railroads, and in 1897 he became chief engineer of the Southern Indiana Ry., chief engineer of the Detroit, Toledo & Ironton Ry., and construction engineer and chief of surveys of the Cincinnati, Hamilton & Dayton Ry. From 1906 to 1915 Mr. Crocker was a member of the New York Central Lines' engineering staff, as construction engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., and his last work was done in the legal department of the Boston & Albany Railroad.

JESSE LOWE, engineer and contractor, died Apr. 17 at his home at Beardstown, Ill. He was born at Omaha, Neb., Jan. 7, 1861. In 1880 he was assistant engineer on preliminary location for the Missouri Pacific Ry., in Kansas and Nebraska. After being an assistant in the office of the city engineer of Omaha, in 1884 he returned to the Missouri Pacific, and in 1886 was assistant engineer and then resident engineer on construction. In 1887 he was assistant manager of the Birmingham Bridge & Bolt Works, at Birmingham, Ala., and in 1888 became connected with the engineering firm of Rosewater & Christie at Omaha, Neb. In 1889 the firm of Christie & Lowe, engineers and contractors, was organized, with offices at Chicago and Washington. Large contracts on the Chicago drainage canal and a number of important public works were carried out by this firm. Mr. Lowe retired from active service a few years ago, but took much interest in the development of drainage and levee work for land reclamation. He was graduated from the Rensselaer Polytechnic Institute in 1885. He was a member of the American Society of Civil Engineers, the Western Society of Engineers and the Illinois Society of Engineers.

ROBERT NEILL, for 35 years chief engineer of the W. S. Dickey Clay Works, Kansas City, Mo., died recently in San Antonio, Texas.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

Government Seeks Additional Export Classification Data

With the immediate object of furnishing more detailed and accurate information to the war boards engaged in licensing imports and exports and conserving tonnage, food stuffs and raw materials, a radical revision and extension of the Government's foreign trade statistical classifications has been undertaken by the Bureau of Foreign and Domestic Commerce. To this end industries are urged to make immediate suggestions for new classes of goods that should be shown in the revised trade statistics and classifications.

The bureau points out that in making suggestions for the export classifications it should be borne in mind that the statistics are based on the description of merchandise as shown in export declarations filed by the shippers with the collector of customs at the port of clearance. A too detailed classification going beyond commonly used commercial terms must therefore be avoided. Likewise suggestions regarding imports should be made with due regard to the fact that statistics of imports follow the tariff classification, and that subdivisions for statistical purposes beyond customs requirements are difficult to obtain and are apt to result in inaccurate and misleading figures.

In order to make it possible to put the extended classification into effect for the fiscal year beginning with July 1 next, it is necessary that new schedules and blank forms be printed and placed in the hands of all collectors of customs by that date. All parties desiring to submit recommendations are therefore urged to transmit them to the Bureau of Foreign and Domestic Commerce at the earliest possible date.

Annual Meeting of National Association of Manufacturers

The annual meeting of the National Assn. of Manufacturers will be held May 20-21 at the Waldorf Astoria Hotel, New York City. The first formal session of the meeting will be held on the afternoon of May 20. Incidental to the meeting there will be an elaborate exhibition devoted to "Conservation of Man Power."

Cleveland Associations Initiate Return Loads Campaign

A plan for the establishment of return-load bureaus in northeastern Ohio to obtain freight for motor trucks, for efficient and profitable handling, has been initiated by the Cleveland Commercial Car Dealers' Assn. It is understood that the plan is being backed by the highway motor transport committee of the Cleveland Chamber of Commerce, which proposes to conduct an extensive campaign to bring shippers and trucking companies into closer coöperation for their mutual advantage.

It is planned to urge each chamber of commerce and board of trade in approximately twenty-five cities of the Cleveland district, bounded by the territory of Toledo, Cincinnati, Pittsburgh and Buffalo, to join the movement by forming similar return-load bureaus and coöperating with the central bureau.

A representative of the Cleveland Commercial Car Dealers' Assn. states that the territory has been carefully mapped out and that the next step will be to effect an understanding between shippers and truck operators. The committee of the car dealers' association is collecting the necessary data through the use of questionnaires which are being filled out by the shipping and trucking interests.

Meeting of National Lumber Manufacturers' Association

The 16th annual meeting of the National Lumber Manufacturers Assn. wil be held in Chicago May 20-21. The subjects to be discussed on the first day of the meeting at the trade-extension session include building and loan associations, retail coöperation, developing the use of timber and fitting lumber to consumers' needs. The "Governmental-relations session," which will be held on the second day, will largely be given to discussion of building codes, transportation and national policies in the lumber industry.

Seek Greater Use of Trade Acceptances

For the purpose of bringing about a general use of trade acceptances as a superior method of financing transactions arising from the sale of merchandise, the National Assn. of Manufacturers has become actively identified with the American Trade Acceptance Council, composed of committees of the National Association of Credit Men, the Chamber of Commerce of the United States and the American Bankers' Association.

It is the purpose to further the movement at this time in order to convert so-called "frozen," unavailable book accounts into available assets, eligible for discount at the Federal Reserve Banks as well as to emphasize the importance of terms of sale in selling contracts.

It is thought that the general use of trade acceptances will greatly strengthen credit.

Commercial Use of Steel To Be Restricted

War Needs Much Greater Than Expected—Meeting of Manufacturers Takes Steps to Increase Output

Additional measures for regulating commercial uses of steel are being studied, with the object of establishing a full and concise list of all classes of steel consumption in proper sequence, rather than cutting off the supplies entirely from some industries. Certain consuming industries are now being termed "less essential" rather than "nonessential" to the prosecution of the war, as previously.

The preparation of a preferential list of industries will be necessary, since it is being found that the war program will consume steel products in many more ways than was anticipated at first. It is expected that such a preferential list of less essential industries will be issued which will indicate, on a percentage basis, the amount of steel to be allowed each industry on the basis of previous average consumption.

At a meeting held last week in the New York offices of the United States Steel Corporation, which was attended by 50 iron and steel manufacturers, radical measures were decided upon to increase the nation's output of steel for war purposes. The meeting was called at the request of J. Leonard Replogle, director of steel supplies, who attended the meeting with two of his assistants from Washington to lay before the steel men certain facts regarding the steadily increasing demand for war consumption.

Commercial Orders Held Up

Although little has been made public concerning the results of the conference, it is known that the manufacturers decided to hold in abeyance practically all orders for commercial steel in order to devote the full facilities of the mills and blast furnaces, for the present, to the production of materials for munition factories and shipyards. It is understood that the manufacturers attending the meeting learned enough from Mr. Replogle's presentation of figures on future requirements to show them that the mills would be called upon for more steel later in the year than they had contemplated. The scope of this possible demand may be illustrated by the fact that the plate mills are weekly producing a total of ship plates aproximately 15,000 tons in excess of the quantity produced before the United States entered the war.

Preparatory to the practical development of the preferential program, a complete analysis of steel products due

on commercial orders (as distinct from war orders) is being made. Previous to this time, mills have rendered weekly reports detailing shipments and orders for Government account and for the account of the Allies, but the remainder, spoken of as "commercial" steel, has been reported only in aggregate tonnages. The new reports which will be made will classify this tonnage as to the precise use to which it is to be put, and where mills do not already have this information, they are requiring customers to furnish it.

The desirability of a preferential list of the so-called "less essential" industries is illustrated by a statement made not long ago by a well known manufacturer, who said: "We can show by our list of recent sales that our equipment is essential to industries the continuous operation of which is vital to the war. For instance, the ——— Coal & Iron Co. recently sent us an order for more steam shovels. They are now using 10 of them. The ——— R.R. ordered another ditcher, and you can run your eye over the list and see such names as the ——— Steel Co., the ——— Engineering Co. now engaged in building a new war-industry plant, etc."

While the mills have adopted no definite sales policy in regard to the acceptance of orders, there seems to be a disposition not to sell when it is certain that delivery will be much later than July. Orders now being placed by commercial consumers and accepted by the mills stand a fair chance of being filled toward the latter part of June.

SHORTAGE OF COKE

Production of pig iron is proceeding at about 85% of maximum capacity, as has been the case for the past two months. Formerly various restrictive influences were in evidence, but now the chief restriction appears to be an insufficient movement of coke, shipments of which have been decreasing rather than increasing since the first of last month. It is reported that recent car supplies have been good, but the frequent disappointments of operators after one or two days' good service have resulted in decreased production on account of the uncertainty in obtaining sufficient car supply to move the output.

Commercial requirements for steel remain fairly heavy, while Government requirements are distinctly heavier than ever before. The Government bought heavily last year for needs that could be permanently supplied, but many new lines have developed since then. For the shipbuilding account alone, the plate mills are furnishing 200,000 tons a month.

Notice of Inability to Deliver to Foreign Customers

A United States consular report from Chile indicates the danger of creating ill will against firms in the United States on account of their failure to notify merchants of their inability to deliver merchandise or of delays of shipments which may be expected.

The report suggests that a rule be adopted by all exporters to make acknowledgment of the receipt of the order, at the same time giving information as to the part of the order that can be shipped at once, the part that will be delayed with the period of delay estimated, and the part that cannot be delivered at all, with the reasons therefor.

Prices Fluctuate Slightly as Restrictions of Material Output Begin

Fuel Administration Announces First Definite Regulation of an Industry—Building Trades Strikes Increase

In curtailing the florist industry 50 per cent last week the fuel administration made its first definition of what businesses fall within a given industry, exactly what establishments would be reduced in fuel supply and in what prescribed ways these establishments were to cut their consumption of coal. The great significance of this is that, having applied such methods to one industry, the fuel administration may easily extend them to others; and several of the building materials industries are in line for such action. Indeed, the fuel to be used by makers of clay products has already been made the subject of agreement between the industry and the Government. As yet, this curtailment is not reflected in the prices of clay products.

A great increase in strikes among the building trades has been recorded by a leading statistical organization. Twenty-six such strikes, ranging from Massachusetts to Montana, out of a total of 208 occurred in April. This is a large increase over March. It is perhaps due to increasing confidence of the unions in their position, the number of such workers in proportion to the demand having been greatly reduced by their withdrawal to shipbuilding and other war activities. While wages in the building trades are high, steady employment is more uncertain than ever, lowering thte workers' annual return to a point which may produce still greater dissatisfaction.

Factory construction, in certain representative districts, which touched $25,000,000 quarterly only once before the war, has passed $60,000,000 in two recent quarters and has averaged more than $40,000,000 per quarter for three years. Meanwhile, ordinary building in the same districts has fallen from the peak of almost $125,000,000 in the last quarter of 1916 to less than $50,000,000 in each of the quarters just passed. If these figures are representative, contractors can draw from them the conclusion that after the war the trend of building will be away from manufacturing to office, apartment and warehouse construction. This is especially likely in view of the fact that much of the expansion in factory building has been for war work, and that till most of these plants have been utilized for ordinary manufacturing, little new construction will be required.

As noted elsewhere, on page 88, less than 5 per cent. of the public financing so far submitted to the Capital Issues Committee has been disapproved. This makes it appear likely that work necessary for the war will be acted on favorably and that considerable construction of this sort and of a kind vital to the public health and efficiency will go forward.

Changes in price are few, and movements answer in general only to local conditions. It is considered unlikely that any reduction in construction materials can take place in some time, and further advances are considered certain.

New Rolling Mill Completed at Indiana Harbor

The fourth rolling mill of the north harbor blast furnaces, steel works and coke ovens of the Mark Manufacturing Co., Chicago, has been put in operation at Indiana Harbor, Ind. Since the three new rolling mills were put in operation last fall, a new industrial town has sprung up around the site. In addition to the last blast furnace completed, new open-hearth furnaces, coke ovens, machine shops and ore docks are being constructed. The cost of the plant is estimated at approximately $25,000,000.

Will Make Survey of Warehouse Space in New York City

Building Industries of New York has undertaken to make a survey of the available warehouse space in each of the five boroughs of New York City, and a similar survey of available apartments and tenements for housing workmen engaged in war industries.

The Chamber of Commerce and real estate associations are coöperating with the Building Industries, whose purpose it is to push the work with the greatest dispatch in order to present accurate information as quickly as possible to the proper Government departments at Washington with which it is working.

France to Terminate Existing Trade Agreements

The French Government has announced that all of France's existing 52 most-favored-nations trade agreements with other countries will cease in April, 1919.